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Science & Technology

Central Eurasia: Space

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Science & Technology

Central Eurasia: Space

JPRS-USP-94-008 28 December 1994

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Russian-European Cooperation in Euromir-94 Outlined

957Q0008 Moscow NOVOYE VREMYA in Russian No 40, Oct 94 pp 24-25

[Article by Dmitriy Pogorzhelskiy, dateline Noordwijk and Bonn, under the rubric "Space": "The Euromir-94 Project Is in Operation: How the Collaboration With Russia Is Beneficial to the Western Europeans"]

[FBIS Translated Text] The gray, single-story buildings, similar to barracks, are somehow reminiscent of a Pioneer camp. Huge white seagulls emitting sharp cries soar above the flat roofs. The gusty wind, it seems, is delivering a salty spray—the litt'e Dutch resort town Noordwijk stands on the very shores of the North Sea.

Inside the "barracks," however, you get a completely different, otherworldly feeling. That's where ESTEK is, the technology center for the European Space Agency (ESA). The day I came to Noordwijk, I heard in the corridors of ESTEK my own tongue—there were guests from Moscow, refining some details on the forthcoming flight in the Euromir-94 program. On our side, the project is headed by G. S. Oganesyants; from ESA were Wolfgang Nelessen and Deiter Andresen.

The first of the two planned flights to the Mir station begins on 3 October. In orbit for 30 days along with the Russian cosmonauts will be their German colleague Ulf Merbold. He was chosen because he already has flight experience, albeit on American vehicles. The second mission to Mir is to take place in the middle of next year, also with the participation of a cosmonaut from one of the countries that belong to ESA. These flights are being performed in the context of the Euromir project, in which ESA and a former NPO—now the Russian Space Concern Energiya—are taking part. For the two flights, ESA will pay Russia about $60 million, roughly half what the United States would ask.

By the way, something else about the money, the shortage of which has become the talk of the town. There's no need to assume that ESA is just absorbing millions. Although the agency is not, as they say in the West, an organization that "brings a profit," it ultimately facilitates the development of industry and technologies in the member countries. The slyness consists in the following: an amount equal to the contribution made by each of the countries into the overall pot of the space agency must be returned to each country in the form of national industry orders for the development and creation of instruments and gear. Difficulties arise from time to time. Maybe French firms, in the opinion of specialists, could fill some given order better than anyone else; but Paris has already gotten its contribution back insofar as other orders were placed in France. So firms in some other EC country must be sought out. In addition, such a rotation of money encourages countries to make their contributions, since ultimately ESA creates new jobs. That circumstance was considered as far back as the 1960's, when the agency was being born. At that time, the Europeans understood that they were not in a position to compete with the space "giants"—the United States and the USSR.

But even that doesn't help the problem much, that is, how to "sell" this or that program—what's needed is enough resourcefulness to secure the release of money for "investment in the future."

"Aw, I'll give you a ride!" We won't be doing that anymore

Nikolay Zelenshchikov, the first vice-president of the Russian Space Concern Energiya, doesn't hide the fact that the Euromir project is important to the Russian side mainly from a financial standpoint, since our own money is short.

"We began the commercial flights," says Zelenshchikov, "after we 'gave a ride' to all the socialist countries. We moved to a commercial basis with the flight of the Japanese cosmonaut. The money we get we put into the development of manned space, because the money from the state budget isn't enough. Even though the government promised last year to add to that."

For the Europeans, the collaboration with Russia is very alluring. The many experiments involving life support and medicine can't be done without human beings. That's why they're also taking part in the Alpha project to create an orbital station with Russia, the United States, Japan, and Canada.

But the issue, in fact, is broader: How will the European space program grow in the future? With whom should a more intimate collaboration be set up—Russia, or the United States? This is where the different interests of many departments and politicians collide. While the struggles over the space plans are going on on the ground, ESA has taken a time-out until the end of next year.

"We're offering Europe continued joint collaboration on the development of specific projects," says Zelenshchikov. "We want to carry some sorts of new European equipment. So we're seeking mutual benefit. Next year, the three-year period for which ESA allotted money expires. So we'll have to see how things go.

"You have to look to the future. In many things, we forged ahead of our time when we created the Energiya-Buran system. But as for telecommunications systems, which are the only things that are commercially profitable, we're behind, because we got involved with them in the mid-1960's, but then dropped them. Now, it seems we're going to have to make up for lost time. But there is something else that we can use to try to break into the world space market. And we simply have to, even if that something is not profitable to us. With our prices, we could have filled up the market. But the West—mainly, the United States—insisted that our prices for launching Western satellites be only a few percent lower than the American and European prices. Between now and 2000, we will be able to do only 12 flights."

Russia's achievements are unique

Deiter Andresen, the second director of the Euromir-94 program on the ESA side, feels that all space projects have a substantial political component. "Our job as scientists," he says, "is to fill those projects with the specifics. Naturally, we took into consideration the experience that was garnered in the Russian space program and could be useful to us. Specifically, we wanted to use your potential, your systems—mainly, the Mir orbital station—for our purposes."

Pogorzhelskiy: "Politics is politics, but still, what does collaboration with Russia provide from a purely scientific standpoint?"

"A great deal. Russia can offer a lot on the 'space market.' The Russian orbital station, for example, is unique. The docking modules are unique. Nobody else in the world has that kind of stuff yet. Many countries are interested in sending their cosmonauts aloft in orbit for long durations. Apart from Russia, nobody can offer those kinds of services—the Shuttle flights are designed for a maximum of two weeks. That's why our project can be regarded as one of the first steps on the path to a global international orbital station.

"For our Russian colleagues, that project, it seems to me, is also very important because it enables them to not be so dependent on internal sources of financing."

Pogorzhelskiy: But ESA also has problems with financing, and everybody has been talking about that for several years already.

"In recent years, financing for, say, manned missions has truly been cut back. Before, things were simpler, and the argument sounded something like this: we can't fall behind the others. Now—and this is again due to the changes that have occurred in the world—it's felt that more cooperation is what's needed, so that what others have can be used."

Pogorzhelskiy: Can you imagine that in the near future, collaboration among yesterday's rivals and enemies will lead to the creation of a joint system or a station that could be used for purposes of international safety?

"That's without a doubt. For that, of course, measures are needed that strengthen trust. That's why I think it's very important that Russia open its doors to Western partners. During the recent docking, for example, which didn't go smoothly at all, we were in the Flight Control Center and were kept abreast of what was happening. Five minutes after the docking, we were informed in detail and truthfully about what had happened. Of course, there were some technical nuances we weren't given, but overall we had nothing to complain about. Collaboration with the Russians, for example, gives me great pleasure. I've been involved in space projects for a quarter of a century now, and I know how NASA functions and, naturally, how European agencies function, and now I know how the Russians operate. There are differences, of course, and they're substantial. But it's extremely important and interesting to observe how you achieve the same goals, but sometimes in completely different ways."

Pogorzhelskiy: In Russia, the fears that are heard are quite clear: the West wants to buy up all our achievements, achievements of which we have a right to be proud of, and wants to turn them to its benefit.

"Those fears are unfounded. We're not buying up anything, just using what you can offer us. Nor do we intend to buy your technologies. Here everything is as if on the market: you can offer a finished product, and we can lay of the money for it. This has nothing to do with any kind of selloff of Russian know-how or technological achievements, and certainly not with any loss of prestige. I mean, we're turning to our Russian colleagues with a request and a proposal, all the while acknowledging their leadership in certain areas. By the way, I also know a lot of NASA people who are also putting forward those kinds of arguments. Behind that are fears of losing a monopoly. Before, when the enemy was on hand, everything was simpler, and many profited from the confrontation. But times are changing."

Will they have enough strength?

Pogorzhelskiy: Without man, we'll never get into space not simply because robots can't completely replace man. But medical experiments play a big role in the forthcoming missions.

"In all, we will conduct 22 physiology experiments that we hope will help us better understand the human body," says Benny Ellman-Larsen, one of the directors of the medical research programs and the experiments of Euromir-94. "Some parameters are impossible to ascertain on the ground, where completely different factors act on man. Our Russian colleagues have garnered a great deal of experience in that area. For ESA, it is important that the agency will be able to send a cosmonaut aloft for a lengthy period for the first time ever. The Americans have been aloft for a maximum of 14 days. By the way, some processes associated with man's becoming accustomed to space conditions take a minimum of two or three weeks. And it's extremely important to determine how the human body behaves on such long missions and whether the cosmonauts will have enough physical and emotional strength to control the craft after several months in space.

"ESA has enlisted clinical physicians and researchers from many European countries to work on that problem during the joint mission. But preparing that kind of mission and that kind of program of experiments would require about five years with the Americans. But in the next experiment, planned for the coming year, ESA wants to conduct two completely new experiments for which special gear is being created."

Pogorzhelskiy: You've done business both with the Americans and the Russians for a rather long time now. Which is more interesting to work with?

"It's a great pleasure to work with the Americans and with the Russians," says Ellman-Larsen. "But with the Russians, it's easier to make human contact, something that is not made a requirement in the work with the Americans, for whom it is more important that all the formalities are observed. But with the Russians, good relations sometimes help solve many problems without any extra red tape; they know what can be done and what, maybe, can be done, and they're willing more often to make compromises if we explain to them why we need those compromises.

What strikes me is the openness with which the Russian collaborate with us. Before, everything was classified, closed. Now everything is different.

Cosmonauts Interviewed on Past, Future of Space Program

957Q0014A Moscow MOSKOVSKIY KOMSOMOLETS in Russian 19 Oct 94 p 8

[Interview of cosmonauts Viktor Savinykh, Aleksandr Serebrov, Oleg Makarov and Aleksandr Ivanenkov by Yana Yurova and Yuriy Ryazhskiy, with questions directed to cosmonauts by readers by phone and with interspersed excerpts from journals of prominent space figures and anecdotes; the first five paragraphs are an introduction]

[FBIS Translated Text] In space there is a state of complete weightlessness. And not only in orbit, but also on Earth. There are many causes and they all are quite weighty.

On the one hand there is the severe crisis caused by economic factors. There are increasingly fewer flights and accordingly there also is less interest among the people. Completely unnoticed by either journalists or the public in general, the government has approved a "Space Program for Russia to the Year 2000, Principal Directions in Space Activity to the Year 2010." The leaders of the Russian Space Agency are not allowing broad discussion of some points in this "Program"—why?

On the other hand—there will be money and there also will be man in space and on the other planets. Cosmonautics, and with it some spheres of "defense," medicine and education, most likely will be switched into commercial channels.

By the year 2000 the new program calls for deploying more than 20 space communication systems. As a result of such an expansion there will be an increase in the capacity for telephone communication, radio and television transmission by a factor of 15. The number of Central Television programs will increase from 2 to 6. The plans call for undertakings in the field of navigation, meteorological observation and ecologic monitoring systems....

And in addition: the NPO Energiya, the Lavochkin NPO for Applied Mechanics, the Kosmicheskaya svyaz space communication enterprise, the Scientific Research Institute for Space Instrument Making and the Radio Scientific Research Institute are continuing work on their programs. A quite impressive assemblage for attempting to bring the branch out from its crisis.

Cosmonauts visited our editorial offices on the occasion of the latest anniversary of launch of the first artificial earth satellite into space. They came in order to hold a conversation about cosmonautics and the problems related to it. They, somewhat offended by some not very correct materials published in the press, frankly wanted to answer the questions of our journalists and newspaper readers. Possibly the two days during which this conversation was held were really too little time to cover such a subject. But nevertheless the conversation was held....

The cosmonauts Viktor Savinykh, Aleksandr Serebrov, Oleg Makarov and Aleksandr Ivanenkov participated in taking questions from readers over the open telephone.

"31 December 1968.

Moroz, Kutakhov, Ponomarev, Kutesin, Frolov, I and other Air Force generals met this morning at the main headquarters. Vershinin was yesterday at a session of the supreme political committee where they dealt with the "burning" question: "How to respond to the Americans?" It was decided to counter the successful flight of three American astronauts around the moon by the flight of an automatic vehicle to the moon. Even the simplest thought cannot come into the heads of our leaders: it is impossible to respond to the manned Apollo 8 flight by the flight of an automatic vehicle; no flight of an automatic vehicle can be a satisfactory response. Only a landing of people on the moon and their successful return to the Earth could be a worthy response to the Apollo 8 triumph. But we are not ready for an expedition to the moon; in the best case we will be ready for such a flight after 2 to 3 years."

(From the space journal of General N. Kaminin.)

Q: How much money, energy and simply life has been poured into the conquest of space! Why was it necessary to spend so much on this when there are so many problems on the Earth which still need to be solved? And judging from the fact that from year to year the number of flights is becoming fewer, has it now been decided to be done with space?

O. M.: That is a big question. It is impossible to prove that the conquest of space is vitally necessary for all of us. The same as it is impossible to prove that we do not need it.

In actuality, it now may seem that once flights have become fewer in number the entire space conquest program is being curtailed. But in actuality, it is not the number of flights which is important. No one makes the demand: give us a bigger and bigger TV set. Better quality, that's the thing. Cosmonautics is now expanding in depth and thank heavens that the competitive race between America and ourselves has ended.

How to proceed? In actuality, today automatic vehicles can do virtually everything in orbit. Without man's participation. That is in fact possible. But man in space—in this

there is something attractively beautiful. Certainly it is not by chance that the stars in the infinitely distant sky have always beckoned people to them.

This is difficult to explain in words...

Q: Is the flight of a terrestrial crew to Mars realistic, at least in the next few years?

A. I.: The project itself was worked out long ago and the flight by Polyakov was one of the models of a future flight to Mars. So that sometime we will fly there.

V. S.: Unfortunately, everything is just theoretical. Today not one country in the world is up to this project: money does not suffice.

O. M.: Precisely. It must be understood that Mars is very expensive. And now there is no one who wishes to finance this undertaking. Earlier the prestige problem solved everything. When Kennedy did not want for money for the American space program, all the right conditions for this prevailed. The Americans were offended: how was it that they with their advanced technologies and resources were behind the Russians? And in those days the Americans were ready to pay as much as they had to just to prove to the entire world what a remarkable people they were.

The only solution is international cooperation. When there is money, lots of money, it also will be possible to lay one's sights on Mars. Although technically we already are very close to that capability.

Q: With the USSR breaking up we lost Baykonur, which was built by the entire country. What will happen in the future—will Russia ever have its own cosmodrome?

V. S.: As you know, such projects exist. Russia has Plesetsk, a former military rocket launch site, where it is neat and clean, in contrast to Baykonur. It is being further developed and a launch site is being built there for heavy boosters. We also have Kapustin Yar, where earlier liquid-propellant rockets were launched. There is a launch pad not far from Blagoveshchensk....

O. M.: There are two ways—it is possible to fly from the old Baykonur. This was a good cosmodrome. I say it was, because today it has been very greatly looted.

And it can be acknowledged that there's no love lost there; it's necessary to build up everything anew for ourselves. This variant is better, it appears, but it costs nothing to think, whereas to build—oh boy!

V. S.: Plesetsk is disadvantaged due to its location. If the principal launch site is built there with each launch we will sustain enormous losses. With respect to geography the Far Eastern site is more convenient because it is located even closer to the equator than is Baykonur.

O. M.: Aha, but all "our" principal plants are located in the western part of the country. And the transportation costs will be enormous.

You know, during the first years cosmonauts and engineers were forbidden to fly to Baykonur—it was too expensive. And they traveled by train; then they were forbidden to go by train because it was too slow—they were resting when there was work to be done. And they began to fly. So if the cosmodrome is built in the east, whereas the factories, as now, are in the west, this transportation problem will become totally outrageous.

A. I.: In fact, there is a project for floating launch pads and launches from aircraft. But all this is only a partial solution of the problems.

V. S.: The private opinion of cosmonaut Savinykh. If we are to be called a space power, it is necessary to have our own national cosmodrome. And if we borrow money today from somewhere...

O. M.: ...And never pay it back...

V. S.: ...then the cosmodrome will already pay for itself after five or six years. Anything's better than the shackling agreement with Kazakhstan...

Hard Truth

Killing time in 1943 in the NKVD camp near Kazan, future academician Sergey Pavlovich Korolev suffered severely from the bitter January cold. In order to get through to the spring he asked a civilian worker Moisey Zeydelev to go down to the nearby village and get home brew to warm things up. And he promised: you know, if you get it—I'll never forget you! The "fuel" arrived in time.

Korolev made it through to spring OK. And he did not forget his promises. Already being an Air Force colonel, he sought out his savior, took his boss aside and put in a good word for Moisey. The next day an order was issued designating Zeydelev as leader of a crew working on rocket engine stand tests.

Hard Truth 2

The fact that women are extremely unpredictable beings also was confirmed by the space flight of Valentina Tereshkova. When the "Chayka" had landed and the female cosmonaut was drawn into the bright light all those present were shocked by her swollen and greatly reddened nose. The rumor spread that this was the work of extraterrestrials. It was said that she looked out the window too much. In doing so she got burned.

Later on it became clear: despite instructions, Tereshkova had decided to take a look to see how the parachute canopy had deployed above her. Right then the upper frame of the spacesuit helmet clicked down on her nose.

Q: Is it true that Viktor Savinykh was able to see a ship occupied by extraterrestrials? What did it look like?

V. S.: I can guess roughly where that came from... Some very clever newspaper, maybe KOMSOMOL UZBEKISTANA or something like it, wrote that Savinykh and Korolev for two weeks communed...

A. S.: ...Regularly...

V.S.: ...with extraterrestrials. I still can find no words for reacting to this. It's nonsense, of course.

The chances of encountering extraterrestrials on the Earth are much greater than in space. Different orbits, different velocities... I, for example, during all my flights only twice saw our own terrestrial satellites. There are no special instructions for cosmonauts on the subject of behavior in the event of an encounter with extraterrestrials, even in nature.

Q: Is it necessary for cosmonauts in orbit to execute the orders of the special services—like central intelligence and the State Committee for Public Security?

A. S.: There may be different kinds of information—a great deal can be seen from space. But how to use it, to whose advantage—is a different matter. Let's give an illustration. We flew over the Atlantic and I saw that the American battleship Iowa was making a beeline for Gibraltar. And then a meeting between Gorbachev and Reagan in the Mediterranean Sea was announced, but no one should know of either the place of the meeting or the coordinates.

Well, during a communication contact I reported that I had seen this Iowa and it was going such-and-such a place. Who took advantage of this news, I do not know.

O. M.: To some degree we all are familiar with some problems in reconnaissance. But, first of all, we have no right to speak of this, but then this of course is not our main work. I can say one thing: we do not regard it as shameful to work for the defense of our country.

When I flew over the Far East a local radio station transmitted a recording of the waltz "Amur Waves." The fellows at the station asked:

"Is this interfering with your work? Does it please you?"

I answered:

"Thank you, everything's fine."

The tape was started again and I listened to it on the second, third, fourth revolutions. Delicately I relayed to Earth on the fifth revolution:

"Thank you, friends. You can change the record."

After a minute pause "Amur Waves" again sounded through the ether.

(From the recollections of German Titov).

Q: It is well known that cosmonauts are military people or civilians. Is there any separation among the cosmonauts themselves along these lines?

O. M.: Well now... There is such an illustrious officer as Georgiy Beregovoy. I do not miss a single opportunity to tell him a fresh story about how stupid the military guys are. No big deal. All the same I know no better officer in the world.

A. I: Possibly at the very beginning, when civilian cosmonauts were first allowed, there were stressed relationships. Now that is not the case. There is competition. But it's all for the best, because healthy competition is always a positive factor.

O. M.: Incidentally, when the practice of using civilian cosmonaut engineers began the general level of training in the detachment increased healthily. And this was done purposely by the leaders. Then instead of one (!) examination prior to flight there were approximately fifty. And each (independently, military, civilian) clearly understood: you go, you fly, and no excuses... Right then they explain to you who you are: a so-called "coat," a so-called "boot" or simply a fool.

Incidentally, a story along these lines. One time an officer by the name of Glazkov, wiping away the sweat, left such an exam and barked: "Damnation, I was taken into the detachment due to my health and they ask, what's your IQ..."

Q.: Probably during the time of training our cosmonauts have the very best doctors. But who looks after them the rest of the time?

A. S.: One deputy minister of public health, seeing Grechko's crew off on the first long-term flight, declared: "Dear cosmonauts! Fly with assurance; the very best reanimatologists will meet you back on Earth."

There is a whole series of professional illnesses among cosmonauts. The most vulnerable place is the psyche. The kidneys and kidney stones. In orbit the heart at best operates at half its capacity. At all times I coughed: the vocal cords burned from the excess oxygen in the station. Now they are like mother-of-pearl. I breathe like an asthmatic, although earlier I was a swimmer with a lung volume of 6 liters.

O. M.: We have doctors, extremely well qualified, who monitor our health. But they honestly say: "My job is to write you off." And no one, especially with injuries, can go to such a doctor. Accordingly, many of the cosmonauts prefer to be treated "on the Q.T."

And if you depart the detachment—best regards! You yourself arrange for treatment, you yourself seek medicine....

A. S.: Sometimes such an attitude is simply mind-boggling. My friend Makarov, who had flown for a record time for those days, did not see a single doctor in three years. In essence we were the carriers of highly valuable information for science: how space changes man. Today you find some young woman from a medical institute, one with curiosity, and after a couple of years with us she defends her candidate's dissertation without problems. Because she collects unique information, the only such information in the world.

V. S.: Possibly also not unique, but... After I left the detachment for five years not one doctor remembered me. And in actuality, of course, I should have been of some interest to them.

A. I.: Like babies, really. But who will pay for the doctors?

O. M.: There you have it! That's what really counts in our world—money. And the fact that the people leaving the detachment, regardless of their services, are set adrift. It's stupid....

A. S: And here's something else: in our country medicine operates on a schedule, not being determined by the state of health. With the Americans John Barton, a physicist, who flew once, will now his entire life be examined by physicians in Houston, wherever he lives. He is being fully compensated for transportation and all expenses. The attitudes are at the level: "Your heart is not OK? When will an operation be most convenient?"

In our country, in the best case, when the doctor is freer and when it is more convenient for him.

Q: I would like to know the truth about the death of Yuriy Gagarin. Please tell about how it all actually happened.

(The reasons for the death of the first cosmonaut were touched upon many times by those who telephoned us. The speculation around this name never ceases; evidently this accounts for the large number of questions along these lines—Authors.)

A. S.: The truth is that a very authoritative commission headed by Sergey Mikhaylovich Belotserkovskiy worked at the site of the accident. The principal version was that it was a mishap caused by the pilot of a neighboring aircraft. There also are other hypotheses: the commander felt poorly, his body wedged against the stick. And Gagarin, trying to save his comrade, did not catapult. This is the version given by General Kuznetsov.

Q: And about Komarov, please....

A. S.: One of the versions of the death of Komarov was: the ship flew with a frightful number of shortcomings. Preparations proceeded in haste; incidentally, Gagarin was a backup for Komarov.

The flight itself went off rather successfully, but on the way back... The parachute became entangled during landing. The heat shield was not shot off. The soft landing engine did not fire. And because of all this the velocity of capsule falling was enormous. As was the impact against the ground. The vehicle was consumed by flame. In general, that which was discovered later was horrible....

Version of the death of cosmonaut Vladimir Komarov, told to MK by the specialists servicing this flight.

Vladimir Komarov was assigned to test a completely new multiplace Soyuz ship. The government, as always, was in a hurry: 1967 was an anniversary year and it had to be commemorated worthily! The developers prepared the ship hastily. As a result, by the time of the session of the State Commission about 203 irregularities had been detected in the vehicle.

Knowing about the danger of such a flight, Komarov demanded that more work be done on the ship. In a report to Brezhnev the State Commission timidly noted that there were some troubles and that some time was needed for their elimination. The response of Leonid Ilich was: "I give you twenty-four hours."

The launch went off successfully, but with detachment from the rocket the ship began to rotate about its own axis. Acting under instructions, the cosmonaut tried to stop the ship, but it only spun more.

Power was exhausted. Troubles began to appear, one after the other. Their elimination required going into the service bay, which is airtight but which burns up at the time of landing.

Komarov went there wearing ordinary clothing (in this ship no provision was made for a spacesuit). At that time an automatic alarm indicated that the main cabin had been depressurized.

The cosmonaut immediately understood that this was the end: the cabin no longer could be occupied and the service bay would certainly burn up. Moreover, the oxygen supply in the bay was extremely limited.

Beginning with that moment a verbal skirmish began in the direct communication between the cosmonaut and the Flight Control Center. Looking death in the eye, Komarov cursed all who had been parties to the implementation of this poorly prepared flight. This also included Brezhnev. The cosmonaut swore to the very loss of consciousness, which faded when the oxygen was exhausted

We have all the records of the transducers registering physical parameters which Vladimir Komarov at all times wore on his body. All the stages of his dying, up to the moment when his heart stopped, were recorded in the smallest detail.

When the Flight Control Center received information from the transducers indicating his death they decided to land the ship in an automatic mode. However, since the rotation had not stopped, the lines and parachute became completely entangled with one another and there was virtually no braking. The ship dived into the Earth at near-cosmic velocity.

After the death of Twice Hero of the Soviet Union Vladimir Komarov the leaders of the country did not forget the uncomplimentary words sent in their direction in the cosmonaut's predeath despair. Probably precisely for this reason the government in Moscow did not get around to erecting a monument for the hero or even placing a memorial plaque. Even at the Zhukovskiy Academy, where the cosmonaut had studied, no traces of his presence remained. At the same time that an entire street near the academy was named in honor of the airman

Seregin, who died together with Gagarin. It is understandable that everyone feared the government. And the military all the more.

Q: What is the main task of cosmonauts in orbit? Do they have free time? And what personal things can be brought along?

A. S.: There is always a lot of work to do in the station. Picking up takes a lot of time, as does caring for oneself. Under weightlessness conditions much is involved in conducting one TV communication session: some wire shows up in the frame, and there are a million of them dangling there, this is not professional. You creep along the walls and ceiling with scotch tape and stick the wire down.

But there is enough free time. There are communication contacts with the Earth at rigorously set times. In addition to all kinds of procedures prescribed by the doctors. But beyond that you yourself decide: when you put things in order, when you work with the instruments.

It is more complex with personal things. Now they are trying to approve them, scrutinize them. You will agree that after some examination this thing is no longer personal. I still am corresponding with the public procurator—I want to get back the things and letters which were taken away.

One of the letters was read aloud by my former coworker and they marveled that I could have written it. And I responded that they had violated eight articles of the constitution: confidentiality of correspondence, etc. To which they had but a single answer: "A practice has been established over the years that the correspondence of cosmonauts is considered official business." And therefore it supposedly can be inspected. Gibberish.

V. S.: During my three flights I had no such problems. Possibly all due to the weight restrictions? They allowed each of us to have 1 ½ kg of personal things. Incidentally, for the Americans it is only 250 grams.

Q: How much do the cosmonauts receive—our cosmonauts and the American astronauts? What benefits do they enjoy?

V. S.: The pay of a cosmonaut consists of several parts. In money it is equal to that of a civilian employee at level 18, plus class pay, plus pay for an academic degree, plus extra for length of service. In short on the average it amounts to about 500 thousand rubles.

O. M : Less than a bank guard.

A. S.: We and the Americans have different ideas about money. Once a TV link was set up: on the one end—the Association of Astronauts, on the other end—Polyakov's crew in orbit. We talked with them for 40 minutes via this link and it opened the eyes of the Americans. They later stated that they cannot allow themselves such a thing: so expensive and complex.

An astronaut in their country receives on the average 10 thousand dollars per month. A separate rate of pay during the time of flight.

O. M.: Earlier a cosmonaut was given a car each five years. Under the condition that you swore to hand over the old one to the state upon receipt of the new one. Now such a practice does not exist. Incidentally, in this respect we always were poorer than anyone. When Rukavishnikov flew with the Bulgarians he was given nothing. They said: "The flight was too short." The Bulgarians were offended for their commander and themselves gave him a Volga car. Is that normal?

Officials are always officials. They sincerely feel that the time was long past that they also should be given a car. Why do the cosmonauts always receive a car and they do not? So let no one get a car....

Anecdote—True Story

One of the witnesses to the full ritual of putting a cosmonaut into orbit in a whisper asked a colonel who was standing next to him what the family name of the departee was. Boundless fright was reflected in the neighbor's face. "You've gone out of your mind... This is still a secret!"

Anecdote—True Story 2

Once while in space Valeriy Bykovskiy decided to crack a joke and at the first suitable opportunity reported to the Earth that he had experienced the first "space stool."

Alas, the jest had the directly opposite effect. Those on the ground did not hear the transmitted word "stool" [stul], but the word "knock" [stuk]. Immediately a commotion arose. All levels began to bustle about: what could this "space knock" be? Everything was considered: from a meteor shower to extraterrestrials.

However, when the spaceship again entered the zone of radiovisibility the cosmonaut was asked to describe in detail the nature of the "knock." Right then and there everyone jumped from their seats.

A. S.: In general, however, there were even funnier stories. For example, how our wise leaders changed the last names of the cosmonauts from the socialist countries. Not each and every one of them, to be sure. But if it seemed to someone that something did not ring sonorously for our Russian ear, then....

For example, there was the Polish cosmonaut Hermaszewski, whose name for the occasion of the flight was rendered as Germachevskiy. The first syllable did not please someone. But this is not the worst, listen to this.

There was the Bulgarian Kakalov. He flew as Ivanov. It is recalled that his father was very much against it: everyone said that the family name was ancient, almost princely, if possible... They explained politely to the father: the son can remain Kakalov, but then a different cosmonaut from Bulgaria will fly.

When a participant from fraternal Mongolia was in training, the backup for Kuratchan was the cosmonaut Ganzorik. The name (or family name?) we gave him was Ganzorkhuyak. In their language "khuyak" means "coat of armor."

"20 January 1969

Today it was again impossible to get a good night's sleep—I was already up and about at five in the morning. With Nikolayev, Bykovskiy and a group of officers I headed for site 81 where the launch of a UR-500K booster with the L-1 technological ship was to take place.

The booster was launched very successfully. After the separation of the first stage I got in the car and went to the CP at a second site. At the CP they reported to me that the booster began to fall 501 seconds after the launch. Thus, the automated system put an end to the next flight around the moon.

At the height of preoccupation with clarifying the reasons for the flight termination I got a call from main headquarters, and several minutes later was phoned by Marshal Grechko. Both calls were complaints that in today's issue of PRAVDA there was a photograph of the cosmonauts in which Shatalov, Volynov and Khrunov are still shown wearing the epaulets of lieutenant colonels. These petty complaints of the two major leaders disturbed me to the very core. Neither of them asked me, "Why did the 100-million ruble booster fall?" Grechko had not moved a finger to assist us in space matters and now he was "introducing corrections" into our activity.

(From the space journal of General N. Kamanin.)

V. S.: All of us are very much concerned about what will happen in the future with our national cosmonautics. Everything is dependent on how the authorities and simply the people begin to act toward it. Personally I see how at the institute students today are not coming into my field of specialization—optics, where earlier there had been stiff competition. All the old students are leaving and the young people prefer management, so that after several years there will be no one who will be able to work in space.

Such is the present state of affairs.

You probably noted: in large part the discussion, beginning with "global" issues, toward the end smoothly underwent transition to the "particular," matters of an everyday character: "why and how much?." Which only confirms the last conclusions of Viktor Savinykh: now is the time for cold calculations. It is the time for the delight at the majesty of man, exerting the prerogatives of angels in the sky, somehow to be replaced by a return to all the aspects of mundane existence.

Whether we are a leading space power or not. Whether we need cosmonautics or whether we entrust everything to automatic vehicles and spend the billions on terrestrial, immediate problems. Total "weightlessness."

MK intends to continue with the discussion of cosmonautics. All who are interested in the subject of "man-space" interrelationships can participate in this discussion.

Present and Future Russian Boosters

Name	Load mass in tons	Cosmodrome	Status
Tsiklon	3.6	Plesetsk	in operation
Kosmos-M	1.8	Plesetsk	by 1998
Kosmos	1.5	Plesetsk	in operation
Rokot	1.85	Svobodnyy	by 1996
Neva	5.0	Plesetsk	after 2000
Soyuz	7.1	Baykonur	in operation
Molniya	1.9	Plesetsk	in operation
Zenit	13.2	Plesetsk	in operation
Soyuz-2	6.8	Plesetsk	by 1998
Proton	20.8	Baykonur	in operation
Proton-M	22.0	Baykonur	by 1998
Angara	24.0	Plesetsk	by 2000

Space Officials Criticized for Insufficient Concern Over Mir Station

95UQ0071A Moscow KOMSOMOLSKAYA PRAVDA in Russian 25 Oct 94 p 2

[Article by Yuriy Stepanov: "'Black Tuesday' for Space—That's When There Is No Light and Communication"]

[FBIS Translated Text] "Black Tuesday" on the currency exchange eclipsed all other events and for a long time riveted the attention of the press. While the jumps of the dollar were being watched there were few who noted that precisely on that day—11 October—the next drama in Russian cosmonautics had unfolded: a malfunction of the power supply system occurred in the main unit of the Mir orbital complex which resulted in a loss of orientation on the sun. The drama of the situation was further accentuated by the fact that the storage batteries carried aboard the station discharged to zero and for some time there was no communication with the complex at all.

In this situation the cosmonaut Yuriy Malenchenko was again aloft (we recall: early in September it was precisely due to his experience that it was possible to dock a recalcitrant Progress cargo ship on the third attempt). Yuriy sat at the controls of his Soyuz TM-19 and turned the Mir station together with the solar cells mounted on it in the direction of the sun. As a result the electric power which began to arrive brought the orbital complex to life.

No one has officially indicated the true reasons for the exceptional situation in space, although there is a need for analyzing them—otherwise we are not insured against a repetition of the situation in the future. And to cover up the mishap is completely ridiculous: first of all, the time for this has passed, and second of all, the German Ulf Merbold is now aboard the Mir and he, of course, is reporting to the

European Space Agency in great detail about his flight with the Russians. And if we are counting on a broadening of cooperation with the ESA and NASA it follows that it is time to desist from total hushing up of our space failures, be honest both to our partners and to ourselves.

Our cosmonautics, however, is not striving very much to part with its secrets. Much in our cosmonautics from the moment of its birth was based, putting it mildly, on unreliable information (for example, it was asserted that Yuriy Gagarin landed in a descent module, although in actuality he was catapulted from it prior to landing by parachute: soft landing systems still did not exist at that time). And how many know that 16 of the 46 launches of our vehicles to the moon were unsuccessful?

Yesterday at Baykonur there was still another black day for the cosmodrome. Such a coincidence: on 24 October 1960 a Yangel rocket blew up there with a loss of 92 lives (Marshal Nedelin was among those who perished), and after four years—on 24 October 1964—there was still another rocket explosion, this time a Korolev rocket, and another nine lives were lost. The country for long years knew nothing of these two tragedies, nor about smaller accidents, and instead the TV day after day monotonously fed to the people the cliches: "The flight went normally... The crew is in good health..." Is that not the reason why the romance of the first space years wore out so rapidly, to be replaced by a complete indifference to this highly interesting sphere of human activity?

However, why mention about the simple taxpayer if the truth is sometimes even concealed from the cosmonauts themselves? To be sure, all this was done and is being done under the specious pretext of strengthening of the international prestige of the country. But in fact, if one speaks of international cooperation in space, precisely this will turn partners to distrust. Space secrets continue to multiply. For example, until now no one has officially announced the reasons for the most recent space flight accident: the collision on 14 January of this year between the Soyuz TM-17 spaceship and the Mir orbital complex, the consequences of which were eliminated by Malenchenko and Musabayev emerging into open space.

In the Mir station, where Yelena Kondakov is now present, the space quarters obviously were not designed for the simultaneous presence of six persons for 30 days; the on-board life support system was forced to operate constantly at maximum loads and expend greater energy than usual. Even the bath required increased electric power usage... In addition, the ESA experiments carried out by Ulf Merbold made heavy demands on electric power. Is it possible that while still on the ground our specialists spent no effort in calculating what the energy expenditures would be when the experiments were being conducted? Without question the owner of the Mir complex—the Energiya Rocket-Space Concern (RSC)—is doing everything for the unconditional fulfillment of the contract signed with ESA, for which it has already been paid in hard currency, even if it is necessary to curtail some "Kazakh" experiments.

In general the present 16th and 17th expeditions in the Mir station have experienced more than a few nonstandard situations and therefore it is of interest how the responsible service personnel on the ground are responding to them. For example, Boris Ostroumov, deputy general director of the Russian Space Agency, during the unsuccessful attempts to dock the "obstinate" Progress M-24 cargo ship with the Mir station, on 31 August declared to an ITAR-TASS correspondent that "everything is proceeding normally" (?!) and "equipment being equipment, it will break down." Other answers of Mister Ostroumov also are at variance from the truth. But why point the finger at Ostroumov when Yuriy Koptev, head of the RSA, himself compares the Mir with an automobile, forgetting that it is one thing to have a machine malfunction on the Earth, whereas an orbital complex is there in space! And the almost 1200 irregularities, for some reason or another called "remarks," registered aboard it during the entire period of operation are an inadmissibly great number.

Our own RSA, established, as has now become fashionable, in the likeness of the American NASA, nevertheless has not risen to the "States" level, in particular in its approach to business and responsibility for its activity. Certainly in the United States a manager of the Ostroumov type would immediately be dismissed from his job either for incompetence or for intentionally leading the press astray. But that is the way they do things there...

However, as long as Russian television news programs continue with enviable constancy showing frames of the eruption of the Kamchatkan volcano Klyuchevskaya sopka, photographed by the American Shuttle, but not from aboard our Mir, any arguments advanced in support of Russian cosmonautics will be flimsy. Or in the RSA are they now more interested in surveys from the Shuttle than from the Mir? Incidentally, the resolution of our equipment is no worse than that on the Shuttles...

These, to be sure, are details. But if we do not introduce into our operational norm truthful information on the state of the space branch it will scarcely be possible to talk of return of prestige and respect to it.

Plasma Instabilities and Space Vehicles

957Q0019A Moscow PRIRODA in Russian No 8, Aug 94 pp 48-55

[Article by A. Yu. Olkhovatov, candidate of physical and mathematical sciences, senior scientific specialist, Radio Instrument Making Scientific Research Institute]

[FBIS Translated Text] A great amount of information on ionospheric processes has now been accumulated. However, in the interpretation of the observational results and especially in the construction of theoretical models a number of problems arise which are related to the paucity of data on the properties of real ionospheric plasma. In actuality, ionospheric plasma is an extremely complex open nonlinear system with various feedbacks. Extremely strong electromagnetic fields, streams of particles, etc. may exist in it, which results in the development of different kinds of plasma instabilities, which can radically change the properties of ionospheric plasma (See Footnote 1) (a radioaurora is a typical example). The theory of such phenomena is only beginning to be formulated and therefore in the study of the properties of real ionospheric plasma a major role is played by experimental methods (injection of chemical substances, radio heating, etc.).

We will attempt, proceeding on the basis of the observational results, to detect the effect of the factor of an unstable state of ionospheric plasma on the disturbances generated by the motion of a cosmic body (spacecraft, bolide, etc.) in the ionosphere.

It appears that in some cases this results in the appearance of the most diverse effects accompanying the motion of a cosmic body and, judging from some data, their effect may be manifested at scales up to planetary.

First a study will be made of the development of ionocyclotron instability under the influence of transit of a space body. This instability is of special interest because the waves generated by it have low phase velocities along the geomagnetic field and they are easily generated by electric currents flowing along the geomagnetic field. Next we will discuss some phenomena caused by the development of other types of plasma instabilities which it is now difficult to identify. And finally, we will discuss the effects caused by the influence of particularly powerful disturbances (bolides, rockets, etc.).

Ionocyclotron Instability

We will show that with an unstable state of ionospheric plasma caused by the presence of an ionospheric electric field the motion of a space body under definite conditions may lead to the generation of ionocyclotron plasma instability. The following is meant by the term "ionocyclotron instability." In the ionospheric plasma present in the geomagnetic field the charged particles (we will be interested in electrons and ions) can freely move only along the geomagnetic field lines of force. With motion across these lines the Lorenz force, which "twists" a particle about the geomagnetic lines of force, as a result of which it moves along a circle in the plane perpendicular to the geomagnetic field lines of force, comes into play. The frequency of revolution of a particle is called the cyclotron frequency f_c and is determined using the formula

$$f_c = \frac{|q|B}{2\pi m},$$

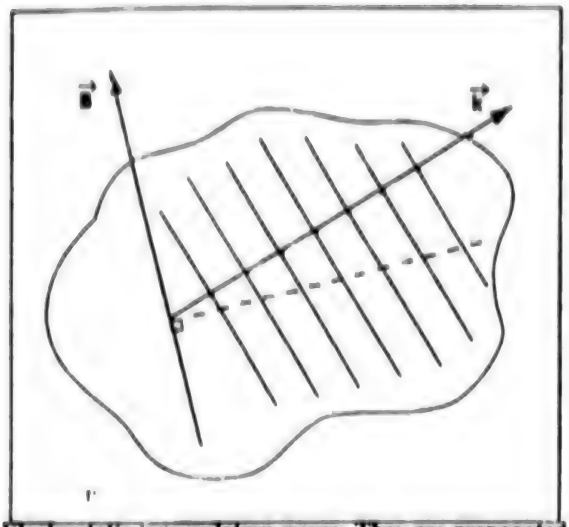
where q is the electric charge of a particle, B is geomagnetic field induction, m is particle mass. Depending on the type of ions f_c in the ionosphere is tens-hundreds of Hz and for electrons is 1.4 MHz. Anisotropy in the motion of particles results in anisotropy of many plasma properties relative to the direction of the geomagnetic field lines of force. Thus, if ions at some moment in time are displaced in a direction close to the perpendicular to the geomagnetic field lines of force, they will be acted upon not only by attractive forces from the direction of the electrons, but also by the Lorenz force. As a result so-called electrostatic ionocyclotron waves are generated whose frequency can be determined approximately using the formula

$$f_{ww} \simeq \frac{1}{2\pi}\sqrt{(2\pi f_c)^2 + k^2 v_s^2},$$

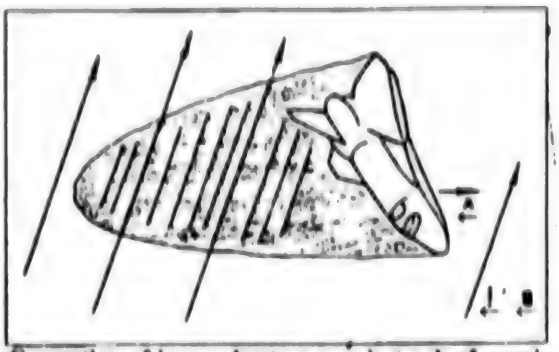
where k is the wave number, v_s is the velocity of ionosonic waves, that is, waves generated by the same method under the condition of displacement of the ions along the direction of the geomagnetic field lines of force or in the absence of a magnetic field. Whereas the ions are displaced precisely in the direction of the perpendicular to the geomagnetic field lines of force, the electrons, whose orbital dimension is much less than for ions, cannot fully follow the ions. In this case so-called lower-hybrid (lh) oscillations with a frequency approximately

$$f_{wr} \simeq f_{ce} \cdot f_{ci},$$

arise, where f_{ci} and f_{ce} are the cyclotron frequencies of ions and electrons respectively. In order of magnitude f_{lh} in ionospheric plasma is several KHz. We will limit ourselves to an examination of the generation of ionocyclotron waves and lower-hybrid oscillations (as their degenerate case) under the influence of an electric current flowing through ionospheric plasma along the geomagnetic field lines of force. Such a situation is frequently observed in the high-latitude and especially in the auroral ionosphere. If the drift velocity of an electron at least a little exceeds the velocity of motion of the wave phase component along a geomagnetic field line of force, the electrons begin to convey their energy to the ionocyclotron waves. In this case it is said that ionocyclotron (lower-hybrid) instability develops. It goes without saying that the real picture is many times more complex,



Electrostatic ionocyclotron waves. They are propagated along the wave vector k, whose direction is close to the normal to the geomagnetic field lines of force B. When k is perpendicular to B the ionocyclotron waves degenerate into lower-hybrid oscillations [in these cases k and B carry the vector symbol].



Generation of ionocyclotron waves in track of cosmic body. In the case of flowing of an electric current j [j bears the vector symbol] in the ionosphere along the geomagnetic field lines of force in the track of the body the drift velocity of the electrons (due to an electron concentration decrease) is increased and may exceed the critical levels. This results in the generation of ionocyclotron waves and under definite conditions also other types of waves (Alfven, magnetosonic and others). The real picture is much more complex because the considered process is not only nonlinear, but also has numerous feedbacks. Accordingly, it is not precluded that in some cases the region of generation of plasma waves may extend far beyond the limits of the zone of reduced electron concentration.

but such a description is evidently adequate for understanding the idea of what is transpiring.

One of the consequences of motion of a body through ionospheric plasma is the formation of a region with a reduced electron concentration in the track behind the body (See Footnote 2). In those cases when the body injects gas (gas release: by the surface, shipboard operating engines, flight life support systems, etc.) the region of reduced electron concentration is broadened, primarily due to the expulsion of ionospheric plasma. The influence of this effect on the development of plasma instabilities can be explained in the following way.

In the ionospheric F-layer, with the usual electron concentrations 10^5 cm^{-3} the critical current density for the development of electrostatic ionocyclotron instability is determined by the electron drift velocity and is about 10^{-4} A/m^2. We will now assume that in some ionospheric plasma region there is an electric field generating a current density somewhat less than the critical value (such a situation arises rather frequently in the auroral ionosphere). If a region with a reduced electron concentration now appears on the electric current path, it follows from the condition of conservation of a constant current density that the electron velocity in this region must increase by the same number of times as the electron concentration in it decreases. Thus, the electron velocity may exceed the critical value, which results in the development of ionocyclotron instability.

The existence of such a mechanism was checked in experiments with the injection of gas into the auroral ionosphere when the generation of instability causes an interruption of the electric current and the generation of Alfven waves. And this finally leads to an impact on the magnetosphere, including an influence on the leakage of particles (See Footnote 3).

Now we turn to the case of a moving cosmic body. An analysis indicated that the influence of the described mechanism should lead to the following:

in the neighborhood of the body there is generation of ionocyclotron waves with lengths of about a few to tens of meters which scatter radio waves of approximately the same lengths, especially if their direction is close to the direction of the perpendicular to the geomagnetic lines of force;

the body is a source of Alfven waves;

there may be an influence on the leakage of particles along a geomagnetic field line of force passing through a body with the corresponding consequences.

We will compare these conclusions with observational data. A great amount of observational data on the effects associated with the motion of a body in ionospheric plasma was obtained in the late 1950's during observations of the first artificial earth satellites. We will concisely present the results (See Footnote 4).

It was discovered that the transit of a satellite through the auroral region (especially the radiation belts), and to a lesser degree, the low-latitude ionosphere, results in an

increase in the strength of the radio signal of a surface radio transmitter operating in the decameter range reflected from the ionosphere and the corresponding scattering surface attains several square kilometers. At this time the decameter radio signal of the satellite radio transmitter faded and fluctuated. In many cases the period of increases in the reflected radio signal coincided with the period of satellite tumbling. It also was noted that the transit of a satellite through the auroral region in the southern hemisphere with a lag of 2-3 minutes causes a strengthening of the radio signal reflected from the ionosphere near the northern auroral region.

A study of the spectra of a reflected decameter radio signal revealed the existence of several possible types of spectrum:

a noiselike spectrum separated on both sides of the carrier frequency of a surface decameter transmitter by several KHz;

a quasicoherent signal consisting of sound components covering many hundreds of Hz with irregular parameters;

a tone of 350 Hz, superposed on the principal signal.

From time to time there is a coherent signal corresponding to the velocity of the satellite as if with reflection from a "cloud" moving together with the satellite.

A study of the influence of satellite transits on the propagation of a radio signal when using a decameter radar revealed that in those cases when an influence of satellite transit through the auroral zone on radio signal propagation is observed the satellite is a source of "reflecting clouds" propagating at velocities from 30 to 150 km/s along the geomagnetic field lines of force. Cases also were noted when the disturbance was propagated across the geomagnetic field.

The use of radar at a frequency of about 100 MHz made it possible to establish the following. In a study in the middle latitudes (Oklahoma, United States) in the neighborhood of the moment in time of satellite transit through the antenna directional diagram there was a statistically significant increase in the number of radar reflections from the ionosphere without an appreciable frequency shift with an effective scattering surface on the order of the corresponding value for the satellite or exceeding it. Most of these reflections were observed when the satellite was situated several hundreds of kilometers to the south of the sounding site. In a study in the high latitudes (Finland) most of the reflections with a near-zero frequency shift also were observed when the satellite was situated several hundreds of kilometers to the south. Accordingly, it was postulated that the disturbance generated by a satellite (possibly a MHD wave) is propagated downward from a satellite along a geomagnetic field line of force into the lower ionosphere.

A detailed analysis revealed (See Footnote 5) that the time difference between those cases when a satellite generates a disturbance, being situated to the south of the observation site or to the north, is about 12 hours, which agrees with the assumption of an influence of ionospheric electric currents because the latter change their direction at a given place each 12 hours. In addition, between the results of observations in Oklahoma and in Finland there was a 7-hour phase shift which approximately corresponds to the difference in the geographic position of the measurement points. The radar observations in Finland also revealed the existence of reflections which were interpreted as the "ion trail" of the satellite when the latter was situated at latitudes close to 65°N, moving from west to east. These reflections were usually observed in the presence of auroral ionization and F- scattering. The duration of reflections averaged 2.5 s and the effective scattering surface attained 1000 m^2. The reflections in their character resembled mirror reflections.

Some of the cited effects are fully consistent with manifestation of the postulated mechanism of lower-hybrid instability. This applies, in particular, to the nature of the spectrum of a radio signal reflected from the region of the disturbances (presence of components corresponding to the cyclotron frequencies of ions and their harmonics, Bernstein modes, etc.), the propagation of a disturbance region along the geomagnetic field lines of force, correlated with the direction of ionospheric currents. The fact that the intensity of the disturbance had a period corresponding to the period of satellite tumbling also is evidence supporting the existence of the proposed mechanism. We note that most of the discussed experimental data were obtained during periods of high solar activity when the presence of ionospheric plasma inhomogeneities was extremely probable.

It can be added to what has been stated above that the formation of an ionospheric plasma disturbance at distances of several hundreds of kilometers along a geomagnetic field line of force from a source—a geophysical rocket—was discovered under conditions of strong F-scattering, characterized by a high level of ionospheric plasma instability (See Footnote 6).

Other Instability Cases

Not all of the effects registered during satellite observations are attributable to the development of lower-hybrid instability. This applies to velocities of disturbance propagation (from 30 to 150 km/s) not corresponding to Alfven waves, propagation across the geomagnetic field, existence of a coherent reflection from the "cloud" moving together with a satellite, mirror reflection from the track and a number of others. We will examine them in somewhat greate detail.

Propagation velocities of 30-150 km/s are characteristic for magnetoionospheric wave disturbances which hypothetically are caused by the presence of an unstable state of ionospheric plasma. They are characterized by a nondependence of propagation velocity on direction. Interpretation of a coherent character of the reflected signal and mirror reflection from a satellite track, which

evidently is none other than different aspects of the very same phenomenon, is difficult. In actuality, this requires that the electron concentration in the satellite track be not less than 10^8 cm^{-3}, which exceeds the ambient concentration by two or three orders of magnitude. We will discuss the possible reason for this phenomenon. The development of lower-hybrid instability (as, however, also many others) results in an increase in the plasma electron temperature. In actuality, there are observational data indicating that in the neighborhood of a space body there may be a considerable electron temperature increase. This is indicated, in particular, by the results of rocket and satellite soundings of the ionosphere.

The following phenomena were discovered in rocket soundings of the ionosphere:

a temperature increase of ionospheric electrons in the track behind the rocket body in the auroral ionosphere, correlating with the leakage of particles (See Footnote 7). A similar electron temperature increase in the track also was discovered in the low-latitude ionosphere (See Footnote 8);

an electron temperature increase on the windward side of the rocket body hypothetically caused by rocket entry into an auroral zone with a high electric field strength (See Footnote 9). This effect was manifested most clearly in the form of a stream of electrons with energies greater than 2 keV, attaining 6×10^{10} el/($cm^2 \times s \times sr$). It is postulated that this phenomenon is attributable to some still undetected characteristics of interaction between a space body and ionospheric plasma under F-scattering conditions.

Epithermal electrons may result in considerable additional ionization of the medium in the neighborhood of and in the track of a satellite, which possibly also explains a number of the noted effects (mirror reflections from the track, and others).

The formation of epithermal electrons should result in the excitation of medium luminescence due to electron collision. It is not impossible that this factor is responsible for the anomalously strong radiation of satellites in the IR range which is occasionally registered (See Footnote 10). In this connection it is impossible not to mention the existence of such a phenomenon as the glow of the blue trails of meteors, which sometimes is observed at anomalously great altitudes up to 160 km, where meteors usually are not visible (See Footnote 11). A similar phenomenon has been observed several times by cosmonauts during descent of Soyuz spacecraft from orbit. It involves the appearance of a quite bright bluish glow of the medium in the neighborhood of the spacecraft at altitudes up to 120 km, whereas usually only a rosy or orange glow of plasma of the impact layer (See Footnote 12) is observed at altitudes less than 100 m.

At an altitude 120 km the shock wave in front of a descent module still has not formed, but the gas-dynamical disturbance introduced by the descent module in ionospheric plasma already is quite great (a "blue glow" was observed during the descent of the Soyuz-10 and Soyuz-23, and also some other Soyuz vehicles). After an attentive study of the published recollections of cosmonauts it was possible to find two other cases when they observed a "blue glow"—descent of the Soyuz-28 and the Soyuz-39" (See Footnote 13).

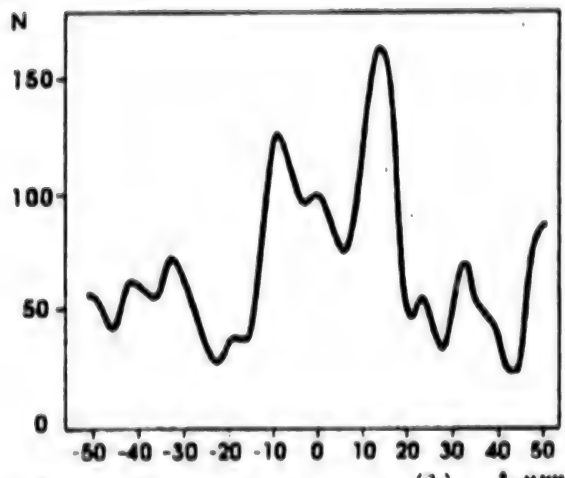
There are a number of indications that the "blue glow" is related to the presence of an unstable state of ionospheric plasma. This is indicated by the fact, in particular, that the descent of the Soyuz-28 and Soyuz-39 occurred at a time when the cosmonauts on the Salyut-6 orbital station observed the phenomenon of an increase in the level of atmospheric glow. As the cosmonauts write, this is usually manifested in the formation of a strong second emission layer which may merge with the first, and the first, in turn, may merge with the Earth's horizon. The duration of this phenomenon may attain a month or more. For example, it was observed from December 1977 to the time when observations ended on 16 March 1978; the descent of the Soyuz-28 occurred during this period (10 March 1978). The appearance of this phenomenon also was registered on 28 March 1981, that is, two days before the Soyuz-39 descent.

With respect to the descent of the Soyuz-10 and Soyuz-23, such observations were not made at that time. However, the fact that this phenomenon is associated with definite geophysical processes (solar activity, etc.), which occurred precisely during the descent of the Soyuz-10 and Soyuz-23 makes the assumption of a relationship between the "blue glow" phenomenon and the phenomenon of an anomalous atmospheric glow of the Earth entirely likely. This is supported by the fact that one of the two maxima in the intensity of anomalous glow in the Earth's atmosphere falls in the region to the south of the Arabian Peninsula (See Footnote 14), precisely where the descent trajectory of the Soyuzes passes at altitudes .+120-100 km.

There also are a number of considerations indicating that the phenomenon of anomalous atmospheric glow is associated with the presence of an unstable state of ionospheric plasma. For example, in surface observations in the anomalous glow region there is an increase in the critical plasma frequencies and formation of electron concentration inhomogeneities, but electron and proton streams are registered in measurements from satellites. The literature notes the existence, evidently, of a similar phenomenon—pale "clouds," persisting for 10-15 minutes after strong auroras and similar to luminescent meteor trails.

Case of Powerful Impact

Now we will examine a case when particularly strong disturbances are generated during the motion of a space body. This usually occurs with the injection of matter into the ionosphere, for example, during the flight of bolides, operation of rocket engines, experiments with



Influence of transit of third Soviet satellite on radio signal reception. N is the number of radio signal surges during 5-minute time intervals; t is time, reckoned from the moment of closest satellite approach to radio reception site. It can be seen that there is an increase in the number of amplitude surges of the signal from a surface radio station operating at a frequency 20 MHz received on the Earth. Intervals -10...-5 and 8...13 minutes correspond to satellite transit through the auroral zone. The curve represents summation for 50 satellite transits (from J. D. Kraus, et al., NATURE, 20 February 1960).

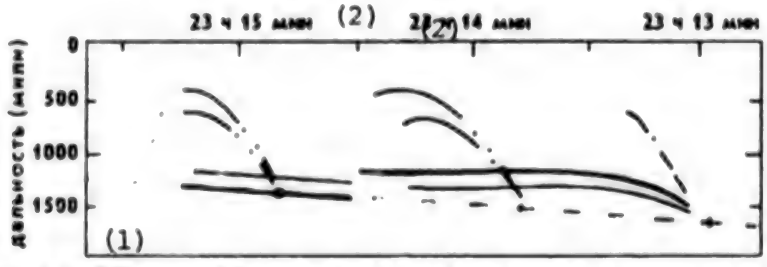
Key: 1. t, min

the injection of matter into the ionosphere, etc. It was noted that the strongest influence of satellite transit on the reflection of radio waves in the decameter range from the ionosphere was observed immediately after a launch when the discharge of fuel remnants and degassing of structural components occurred (See Footnote 15).

At the present time it is impossible to identify all the specific mechanisms of development of plasma instabilities under the influence of the above-mentioned factors, especially if it is taken into account that their efficiency is usually highly dependent on altitude. Here is how witnesses described flight of the Tom bolide in 1984: "Bright streaks suddenly raced through the dark sky. A white-hot sphere with a fiery trail burst from them... (See Footnote 16). An approximately similar phenomenon was observed at the time of falling of the Teleutskoye Lake bolide in 1904 when a red glow, which then turned yellowish, was propagated through the sky, accompanied by electrophonic sounds (See Footnote 17).

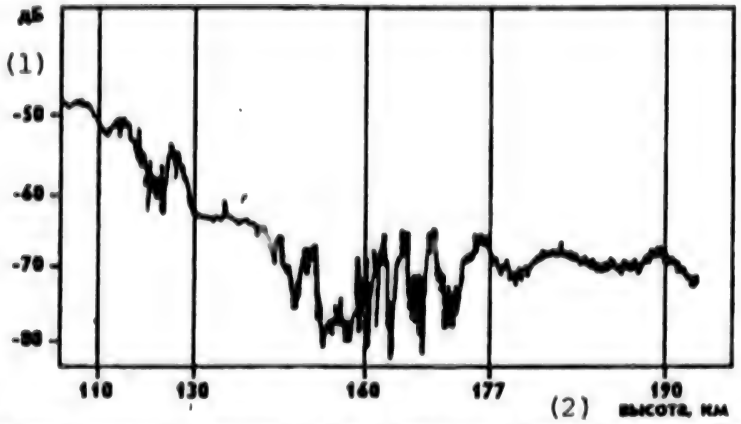
The cosmonauts noted [See Footnote 18] that the transit of a bolide or spacecraft through the atmosphere is capable of leading to the appearance of propagating atmospheric glow waves. We note that a similar phenomenon also may occur during a spacecraft launch. Thus, as a result of firing of the orientation engines at an altitude of about 100 km during the Shuttle launch of 30 August 1983, according to the recollections of the astronauts, for approximately 15 s they were seemingly submerged in a fiery sphere [See Footnote 10]. According to observations from the Earth's surface, this launch caused a glowlike luminescence of the sky visible on the horizon at distances up to 600 km or more from the launch point. Since other anomalous phenomena were observed in the course of this launch, and after several days the launch of a spaceplane in the atmosphere caused a trail glow phenomenon similar to the luminescence of meteor trails, it is most probable that the great magnitude of the effect was caused by an unstable state of ionospheric plasma during this period and the phenomena enumerated above are none other than strong magnetoionospheric wave disturbances.

In all likelihood, such optical effects also are discussed by Couvault [See Footnote 20], whose study indicated that sometimes unusual situations are encountered in which the rocket engine plume seemingly completely "enshrouds" the spacecraft. There also is other evidence that in such cases the role of development of plasma instabilities is substantial. This is indicated, in particular, by the results of a series of Saturn-1 rocket launches when in a number of cases during radio communication with the rocket in some ranges of ionospheric heights there was anomalous fading and fluctuations of the radio signal at frequencies up to 8 GHz (See Footnote 21). An analysis of the situation indicated that these effects were



Influence of transit of third Soviet satellite on radar signal. It is shown that the satellite is a source of fixed and moving reflecting regions. The radio signal frequency is about 17 MHz; the radar ray is spatially fixed; ray width 10°, altitude 50°. Dashed curve—satellite trajectory computed from ephemerides (from J. D. Kraus, et al., 1960).

Key: 1. range (miles) 2. hours and minutes



Dependence of radio signal strength (db) received at Earth from aboard Saturn-1 rocket on flight altitude. Radio signal frequency 250 MHz. Radio signal fadings and fluctuations at altitudes 110-130 and 160-180 km are indicated (in other launches they also are observed at altitudes 215-240 km). The effect was observed only during radio signal propagation through the region of the rocket engine plume. The influence of its exhaust gases on the radio signal is negligible, as is confirmed by the results of other launches (from E. J. Badhdady and O. P. Ely, PROC. IEEE, Vol 54, No 9, 1966).

Key: 1. db 2. altitude, km

evidently caused by some interaction between the rocket engine plume and ionospheric plasma. Meanwhile, available observational results make it possible to ascertain the type of this interaction more specifically. It therefore follows from a comparison of radio signal fadings at frequencies 250 MHz and 8 GHz (See Footnote 22) that the fading cannot be attributed solely to the absorption of radio waves, because this requires frequencies of electron collisions in the ambient ionospheric plasma on the order of 10^{11} s^{-1}, which is much greater than the real values. Moreover, observational results agree with the assumption of a role of radio signal scattering on strong small-scale plasma turbulence generated during interaction between the rocket engine exhaust gas (almost pure H_2O) and ionospheric plasma in an unstable state. The following facts are indicative of this.

In the low-latitude ionosphere, where the launches took place, plasma turbulence is registered most frequently from aboard geophysical rockets precisely at those altitudes at which the already mentioned anomalous radio signal behavior was observed.

It follows from the results of ionospheric soundings in the course of one such launch in which anomalous radio signal behavior was observed that the rocket launch resulted in the appearance of F-scattering and the E_s layer and their regions expanded at rates characteristic for magnetoionospheric wave disturbances (See Footnote 23).

In addition, the evaluation of the parameters of the generated plasma turbulence, capable of giving rise to the observed radio signal fluctuations, made by the author in the geometric optics approximation, indicated that they are characteristic for F-scattering of average intensity.

In all likelihood the presence of an unstable state of ionospheric plasma played a major role in phenomena similar to the Petrozavodsk phenomenon of 1977 in which quasiperiodic airglow of considerable spatial extent (See Footnote 24) was observed during the flight of the Apollo 8 to the moon (See Footnote 25) and in the phenomenon of prolonged luminescence of meteor and other trails (See Footnote 26).

In conclusion we will examine still another aspect of the development of strong plasma instabilities related to the appearance of a quite rare phenomenon, so-called "black" auroras, ionospheric regions where airglow is weaker not only than the glow of adjacent regions, but even weaker than the background glow (See Footnote 27). Moreover, according to the testimony of witnesses, there were cases of a weakening of star brightness during the transmission of their light through the region of a "black" aurora. It seems that the "black" aurora phenomenon is directly related to the phenomenon of formation of dark plasmons in nonequilibrium plasma discovered in the laboratory (See Footnote 28). It was established that these plasmons weaken laser radiation in the visible and IR ranges passing through them.

In summary, we note that the presence of an unstable state of ionospheric plasma plays a significant role in the processes of interaction between a cosmic body and ionospheric plasma and also may lead to the most diverse effects; in some cases this may be of a planetary character.

Footnotes

1. For information on the postulated effects of this factor see: A. Yu. Olkhovatov, IZV. RAN. FIZIKA ZEMLI, No 10, pp 124-128, 1992; A. Yu. Olkhovatov, GEOMAGNETIZM I AERONOMIYA, Vol 30, No 5, pp 844-846,

1990; A. Yu. Olkhovatov, GEOMAGNETIZM I AERONOMIYA, Vol 31, No 4, pp 750-751, 1991. For information on the processes accompanying the motion of a body under conditions of a low plasma instability level see: A. Yu. Olkhovatov, GEOMAGNETIZM I AERONOMIYA, Vol 32, No 4, pp 64-68, 1992.

2. A. C. Tribble, J. S. Pickett, N. D'Angelo, et al., PLANET. SPACE SCI., Vol 37, No 8, pp 1001-1010, 1989.

3. A. W. Yau and B. A. Whalen, ADV. SPACE RES., Vol 8, No 1, pp 67-77, 1988.

4. For more details see: Radar Cross Section Handbook, Vol 2. London, 1970, 866 pages.

5. IBID.

6. F. A. Morse, B. C. Edgar, H. C. Koons, et al., J. GEOPHYS. RES., Vol 82, No 4, pp 578-592, 1977.

7. K. R. Svenes, J. Troim, B. N. Maehlum, et al., PLANET. SPACE SCi., 1990, Vol 38, No 3, pp 395-405, 1990.

8. S. P. Gurta, ADV. SPACE RES., Vol 8, No 1, pp 225-228, 1988.

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12. S. V. Avakyan, L. S. Yevlashin, V. V. Kovalenok, et al., Nablyudeniye polyarnykh siyaniy iz kosmosa (Auroral Observations From Space), Leningrad, 1991.

13. See: V. Remek, Pod nami planeta Zemlya. Vospominaniya (The Planet Earth Beneath Us. Recollections), Moscow, 1981; Zh. Gurragcha, Serdechno blizkiy mir (Belovedly Close World). Moscow, 1988.

14. On possible mechanisms of such processes, see: A. Yu. Olkhovatov, IZV. RAN. FIZIKA ZEMLI, No 12, pp 17-21, 1993. Also see footnote 1.

15. J. D. Kraus, R. C. Higgy and W. R. Crone, PROC. IRE, Vol 48, No 4, pp 672-678, 1960.

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Need Discussed for Protection Against Space Catastrophes

957Q0018A Moscow SEGODNYA in Russian 2 Nov 94 p 9

[Article by Vladimir Gubarev, Nekos Agency: "Shield Against Space Catastrophes"; the first paragraph is an introduction]

[FBIS Translated Text] There are many who must reexamine their points of view, in particular, concerning the possibility of using the enormous energy concentrated in the atomic nucleus. There is no doubt but that it will be used in protecting the Earth, but the task of creating a "space shield" is one which can be handled only by the international community; this cannot be done by one country alone.

Easy living and ignorance destroyed them. Reasoning beings reached satiety and therefore unhurriedly swam through the seas and oceans, where fish and plankton were present in abundance. Sometimes they crept out

onto the land where there were green meadows, beasts inhabited the jungles and giant dinosaurs roamed in the savanna.

This planet in the language of today was called the Earth and on it flourished a civilization, approximately tenth in number. Like the preceding ones, however, it was doomed to be destroyed very rapidly—during the course of only one revolution of the planet around the sun.

Every 300 Million Years

Could reasoning people protect themselves and their planet against a gigantic asteroid whose trajectory intersected the Earth's orbit? Most likely they would be able to do this if they were more foresighted and "a little more reasoning." But too rarely have people raised their heads and looked toward the sky...

An asteroid with a diameter of only a little more than a kilometer struck in the tropical region of a continent later called Atlantis. The explosion lifted into the sky billions of tons of rocks; under the influence of enormous temperatures they combined with water vapor, forming a black shroud which clouded the entire planet. The oceans evaporated. A waterspout, carried over the land, like a gigantic plow, "churned up" the solid ground, exposing the bedrock basement and casting into the abyss luxurious tropical forests which after millions of years were fated to become oil pools.

The night prevailed over the planet for a half-year. Virtually everything living perished and only on tiny "islands of life" did there remain some creatures which were destined after many centuries, after transforming and adapting, to merge into a new life stream... But this will be later on, but 300 million years ago a space catastrophe stopped the smooth flow of life on the planet. Unfortunately, not for the first time.

Strangely an echo of this catastrophe has been heard down to our day. It has been embodied in fairy tales about arrival of strangers from space, gods and celestial chariots, and finally in the concept of the end of the world. The short and harsh word "Terror" has genetically entered into each cell of matter making up the living and rock world of our planet. And this Terror almost always has been related to space, its mysteriousness and its threats.

In the 17th century Megerlin of Basel wrote:

"Like severe intoxication at a feast may cause one person to experience gout, and another stones, and a third colic, and a fourtn a headache or toothache, or a malady of the eyes, not because wine in itself is harmful, since it does not cause disorders in a healthy person, but even refreshes and exhilarates him, but their weak nature cannot withstand such strong stimulation, in precisely the same way calamitous nature under the influence of the appearance of a comet is brought into such strong movement, or to state it more correctly, trembling, which is manifested in unusual events to which there was earlier a predisposition or inclination in one place or another. Accordingly, when it must be decided relative to a comet whether it is an omen of exceptional heat or cold, drought or flood, wind or earthquake, plague or other diseases, or foreign or civil war, uprising, change in government or religion, and in precisely what country it forebodes this, a good foreteller must be not only a deeply understanding physicist or interpreter of nature, but also a far-seeing politician, a person with a good understanding of people, who is able to recognize the present-day state of different countries."

This warning from the 17th century sounds extremely timely, does it not?

Civil wars and changes in government... Drought in America and flooding in the Far East... Cholera in Dagestan and the plague in India... Famine in Africa and the tragedy of Bosnia...

And above and beyond all this—the Shoemaker-Levy comet, which makes mighty Jupiter tremble, excites the imagination of people on our planet and warns them of the impending danger.

Is the world in which we live not truly surprising!

Something else is still more puzzling: that which took place two years ago. Precisely at that time a group of physicists from Snezhinsk, where the Russian Federal Nuclear Center is located, and rocket specialists from Miass, where the State Rocket Center imeni Academician V. P. Makeyev is situated, proposed that an international conference be held on "Problems in Protecting the Earth Against Collision With Dangerous Space Bodies." It's no secret that this idea initially caused a smile among many skeptics; they said—why are we concerned with science fiction? However, shortly thereafter American astronomers discovered a new comet and computations of its trajectory indicated that it might hit Jupiter and then interest in the conference at Snezhinsk began to increase. The events of the summer of 1994, when the amazed world observed the catastrophe on Jupiter, the conference and its results became a center of attention of the scientific community. It is evident that among real scientists there was an increased apprehension of the future, otherwise how to explain that the conference at Snezhinsk, conceived long before the discovery of the Shoemaker-Levy comet, seemingly put an exclamation point on an event which was now fated to enter the history of civilization because in human memory it as yet has been the only such case? We can only surmise about similar catastrophes. Or foresee what the conferees at Snezhinsk would attempt to do.

Fantasy in Diagrams

It was not only the timeliness of the subject matter which brought together in Snezhinsk the scientific elite from different centers in nearby and distant foreign countries. During recent years there has been an increase in the authority of Ural science and many of the institutes

enumerated among the "supersecret" have now been able to make contact with foreign colleagues, and this immediately indicated how great was the potential of Ural scientists and their contribution to modern natural science. However, it is not necessary to go far for examples: Snezhinsk itself, perhaps for the first time, flung open its gates so widely for guests—we will not forget how barbed wire still reliably fences off the nuclear center, famed primarily for its "devices"—nuclear and thermonuclear warheads. To attend a conference in Snezhinsk is naturally a sort of treat.

The All-Russian Fund for Fundamental Research, which is headed by Academician Vladimir Fortov, rendered great assistance in organizing the international meeting. And the appearance among the representatives of the American delegation of a superstar of physics of the 20th century—Edward Teller—finally established the reputation of the conference as an outstanding event in scientific life. For the first time the patriarch of nuclear weapons, the "father" of the American hydrogen bomb, went to the supersecret Russian city Chelyabinsk-70, who would ever believe it?

"The name of the conference is unusual," said Vladimir Nechay, director of the Federal Nuclear Center, at the opening of the meeting of scientists. "However, we are not concerned with science fiction, as some may think, but are trying to solve complex scientific problems. And therefore it is for us to answer two questions exciting mankind. How probable is a collision with a large space body, and if the answer is that such a collision is probable, what catastrophic results might ensue; and second, what can we undertake in order to prevent a catastrophe?

The scientist noted that the Earth retains many traces of collision with asteroids, comets and meteorites and that more than once these events have changed the Earth's appearance and those evolutionary processes which have transpired on it. This can be seen particularly clearly from space vehicles. Precisely from orbit it could be established that there were far more such catastrophes than it seemed earlier. So that threats to the Earth are real.

"The present-day state of science, engineering and technology," added Vladimir Nechay, "indicates that an effective protection of the Earth is entirely realistic. There are a great many projects and rocket- nuclear technology is used in each of them. It is well known that it was developed for the annihilation of people, but now it is finding a use which at first glance is entirely unexpected. Fortunately, for nuclear specialists such an approach is entirely natural because already in the first stage in construction of the weapon we thought about its strictly peaceful application. I ask to be understood correctly," emphasized Nechay, "not a weapon as such, but nuclear devices..."

"Beautifully stated!" commented the outstanding American scientist Edward Teller, who had attentively listened to the report of his colleague. "It is very good that my Russian colleagues understand this difference; unfortunately, in America not everyone recognizes the distinction..."

"The usual situation for progress," agreed Nechay, "conservatism of thought is unfortunately present and therefore there are many who must reexamine their points of view, in particular, concerning the possibility of using the enormous energy concentrated in the atomic nucleus. There is no doubt but that it will be used in protecting the Earth, but the task of creating a 'space shield' is one which can be handled only by the international community; this cannot be done by one country alone."

Vladimir Nechay proposed setting up an international scientific- technical "Space Shield" fund. By the end of the conference working groups of the fund had been organized and proposals on opening regional sections had been submitted.

"Portrait" of Space Interception

The terms at the conference sounded commonplace for the defense specialists. It could not be otherwise: at Snezhinsk the majority of the conferees are working in the rocket-nuclear complex, and therefore the term "space interceptor," introduced into circulation by Igor Velichko, general designer of the State Rocket Center imeni Academician V. P. Makeyev, was regarded as being nothing out of the ordinary. An "interceptor" is an "interceptor."

Several words about the State Rocket Center. Over the course of almost a quarter-century the Makeyev Design Bureau remained in the shadows. In contrast to the space giants, such as Energiya, the Khrunichev Plant or the Chelomey Design Bureau, the "secret facility," which is located at Miass, was not known to the broad public. Moreover, even we, scientific reporters, accredited to secret enterprises, were not allowed to meet with Academician Makeyev or mention his enterprise. We knew that they were working there on missiles for submarines. The abbreviation ICBM, naturally, figured in all the negotiations between the USSR and the United States on the reduction of nuclear arms, but only a narrow range of naval people and rocket specialists knew that our intercontinental missiles on submarines with respect to their tactical-technical specifications were in no way inferior to and in some cases were even superior to American missiles of the same type.

To tell the truth, the address by the chief designer Igor Velichko at the Snezhinsk conference caused a sensation. And not only because he told about what technology the center has at its disposition, but also amazed the conferees with a purely "design approach." Velichko demonstrated computations by his design bureau.

"At the company," he stated, "it was determined what kind of complex was needed for protecting the Earth. In the computations we visualized an asteroid with a diameter of one kilometer and a mass of several million tons.

Two variants were considered: a change in the asteroid flight trajectory and its destruction. However, in the second variant small fragments nevertheless would reach the Earth, and therefore, in our opinion, a trajectory change is the most acceptable and safe choice. The results of our computations: in the case of contact blasts—with a power of 10-20 megatons—an asteroid with a diameter of a kilometer or a comet may receive a velocity increment of 1-2 km/s. Our computations show that the interception of an asteroid is very effective. Again there are two variants: do this 1.5-2 years before collision with the Earth or 30-90 days before. But in the second case this would be a sort of 'emergency defense' and it would have to be accomplished in the zone of the orbit of Venus or Mars. In the case of distant 'interception'—in the orbits of Mercury and in the asteroid belt."

Then Igor Velichko told of a specific project for a "space interceptor" which his company is proposing. This is made up of the "interceptor" itself with a nuclear "device," then a propulsion unit for putting the "interceptor" into a flight trajectory to an asteroid or comet and, finally, a booster for putting the complex into a circumterrestrial orbit. The propulsion unit and the "interceptor" form a so-called "shock module." The chief designer noted that the necessary technology for ensuring the Earth's safety to all intents and purposes has already been developed. In particular, at their Rocket Center there are Briz and Bars units which can be reoutfitted for the propulsion units of the "space interceptors."

"In principle, everything is dependent on the time allocated to us," noted Velichko, "if it is sufficient it will be possible to create a space complex which will not only intercept a dangerous asteroid, but which will come right up to it and make a landing on the surface of the celestial body..."

All this sounded somewhat fantastic, but nevertheless the project proposed by the State Rocket Center is entirely realistic. The conferees went to Miass and visited the enterprise. The unique rocket technology actually had been developed there; it has the most modern test stands and apparatus. In fact, the development of a "space interceptor" is no more complex than the development of intercontinental missiles launched from submarines. Without question the State Center specialists are capable of implementing such a project. And although they have no experience with work directly in space, at the enterprise there are stands simulating space conditions, and this means that the most important part of complex testing can be accomplished on the ground...

It is now fashionable to speak of "conversion." And it is understood rather primitively: they say that it is necessary to "switch" defense enterprises over to the production of frying pans, sauce pans and flatirons. Incidentally, all these are now filling the warehouses: there is no market. And it could not be otherwise because intellect is the most precious thing in this world and it must be used in solving the most complex and timely problems. The example of the State Rocket Center is evidence of this. If its proposals on the development of a "space interceptor," as well as on the formulation of new principles for the launch of commercial satellites into space (there also are such projects), are adopted, this will justify both the material and intellectual expenditures on setting up the center. And if the rocket specialists are afforded the possibility to construct not only intercontinental missiles for submarines (Russia will not be able to get by without them in the foreseeable future), but also systems for the protection of the Earth against asteroids and the new space vehicles so necessary for modern communication and navigation, the term "conversion" assumes a deep rather than a superficial meaning.

Doubts of Astronomers

Tom Gehrels is one of the best-known American astronomers. For many years he has been working at the famed University of Arizona, where he heads the planetary laboratory. It is entirely natural that he considers our solar system, its planets and asteroids, to be "his bailiwick" and therefore not everything expressed at the conference pleased him. In addition, at Snezhinsk he not only expressed his own opinion, but also cited the arguments of 120 leading planetary scientists who have worked on a grandiose monograph devoted to the prevention of a catastrophe from space. Gehrels became the compiler of this book.

"The pages of the book for the most part give the studies of American and Russian scientists," said the professor, "since most of the work on this problem is being done precisely in these countries. The 300-page book is unlike any other ever published in the world."

Science is founded on contradictions. The joint investigation of the international group also could not avoid them. It is asserted in the book that there is a real danger for the Earth and its population: this is supported by history. Indeed, for the first time scientists through their common efforts have analyzed all known and postulated catastrophes. Moreover, they do not deny the possibility of the death of ancient civilizations because of them. The example of the dinosaurs is already becoming standard reading material. It also is asserted in the book that "the destruction and deflection of a killer asteroid is not a superhuman problem." So what to do? Let's immediately proceed to the creation of a "space shield"! However, most of the authors ask that a system for protecting the Earth not be created right now.

An unexpected conclusion, is it not? We can save civilization, but...we ought not do this!

"The danger is great," says Professor Gehrels, "but the probability of a catastrophe is negligible. Indeed, we do not know the size of the asteroid which would cause a catastrophe, particularly since its metal variant, to be sure, should be of a lesser size... However, astronomers for the time being are unable to predict precisely from

whence the danger threatens. At the same time nuclear specialists are exhibiting excessively great interest in the problem and they propose the immediate construction of special apparatus for the annihilation of dangerous celestial bodies. Astronomers ask: do not create new 'devices' and do not conduct tests in space! Due to instability in the modern world it is impossible to open a 'space niche' for the development of new types of nuclear weapons..."

It seems that in America the discussion between the representatives of the nuclear complex and professional astronomers is already heating up. The latter fear that the nuclear tests race will be transferred into the region of the orbits of Mars and Venus. And Professor Gehrels clearly expressed an opinion which is directly opposite that which Edward Teller advocated at the conference.

Teller calls for carrying out experiments with the use of nuclear devices on the asteroids already in the next few years. Gehrels very firmly objects to this. And agreement among American scientists is not foreseen. The "battle" continued to the adoption of a final Appeal to Scientists of the Planet and Governments of All Countries. Edward Teller nevertheless succeeded in deleting the phrase "including with the use of nuclear devices" in the section where it mentions the conducting of experiments on asteroids.

Our scientists did not participate in this dispute: it was hard to hear, but it is precisely the Americans who will play the principal role in creating the "Earth's space shield" because the funding of the work for today is their job. If the American government goes along with it, this means that the research will be continued. If not, it will be necessary to await the time when the Russian government will be able to fund projects for defending our future. Unfortunately, in the upcoming years this most likely will not occur.

...The conference at Snezhinsk can be perceived differently. Probably people will be found who will accuse the rocket and nuclear specialists defending the new project of all conceivable and inconceivable sins. They will say that these people do not want to throw their "devices" onto the scrapheap of history and are striving to adapt them for use in space... Very well, and such a point of view has its right to exist if ... if only some new Tunguska meteorite does not tumble down on our heads and we will only be able to regret that we were so short-sighted.

Russians Offer New Energy Concept for Space Stations

957Q0017A Moscow SEGODNYA in Russian 3 Nov 94 p 7

[Article by Mikhail Chernyshov: "Russian Engineers Propose New Energy Concept for Orbital Stations. It Will Be Tested on the Alpha"]

[FBIS Translated Text] Virtually all orbital complexes are faced with the problem of an inadequacy of on-board electric power. The principal power source for them has been panels of solar cells—enormous wings consisting of thousands of photoelectric cells transforming the radiation of our sun into electric current, in turn supplying power to the life support equipment and scientific instruments. Although the panels have come into very wide use in world cosmonautics, according to Anatoliy Koroteyev, academician, Russian Academy of Sciences, director of the Thermal Processes Scientific Research Institute (NIITP), they are not without serious shortcomings.

Being of great size, the panels impart to a space vehicle not only an imposing appearance, but also a "sail-like" look, because there is no absolute vacuum even in space. Light pressure also exerts an influence on orbital movement. Under the influence of these factors the station becomes difficult to control and additional fuel expenditure is required for an orbital correction.

There also are other shortcomings. It is difficult to conceal the unwieldy panels beneath the cowling when putting a rocket into orbit. And most importantly, the "solar wings" under the influence of radiation, temperature drops and space dust age relatively rapidly and lose power efficiency.

On the promising Alpha international station Russian and American specialists for the first time will test a fundamentally new power plant which has a number of advantages in comparison with the traditional power source. A space electric power plant, in many respects superior in its performance to panels of photoelectric cells, has been constructed at the NIITP. The plant includes a turbogenerator-compressor and a system of heat exchangers. An inert gas which is not replaced during the course of operation circulates through the flow channels. The apparatus has the advantage that under surface conditions it is possible to use any primary fuel sources: solid, liquid, gaseous. It has a high efficiency—up to 35%, a low noise level and a relatively low cost.

The models use mirror dishes—concentrators. They are far more compact than panels of solar cells. The nominal power of just one such plant is 10 KW and the voltage is 230 V. The guaranteed useful life is 10 years. There is a system for keeping the mirrors oriented on the sun, which ensures an incoming power flow of relatively uniform strength. In the dark segments of the orbit the power supply parameters are evened out by so-called heat accumulators, which are far more reliable than ordinary electric buffer batteries. The plant also can operate with nuclear power sources. In the space variant the electric power plant is deployed into a working position automatically. Its size in a deployed mode is approximately 10 x 5 m. The mass of the plant together with the heat accumulator is about two tons.

It is believed that this apparatus in the future will become the basis for constructing more powerful space electric power stations: 2.5 MW solar and 5 MW nuclear. Such plants can already be used for heat and power supply for production processes in orbital plants with a high energy consumption and also for supplying power to electric rocket engines of promising transport systems.

Russian Space Projects: Martian Research

957Q0012A Moscow ZEMLYA I VSELENNAYA in Russian No 4, Jul-Aug 94 pp 3-16

[Article by V. I. Moroz, doctor of physical and mathematical sciences, Space Research Institute, Russian Academy of Sciences]

[FBIS Abstract] The present-day status of study of Mars is reviewed as an introduction to a discussion of the Mars-94 project, with a full listing of the instruments to be carried on the vehicle, including their weight, the countries which have developed and fabricated them, and the particular experiments in which they will be employed. The objectives of the project are outlined and some organizational details are given. The project is headed by A. A. Galeyev, academician, Russian Academy of Sciences, and V. M. Kovtunenko, corresponding member, Russian Academy of Sciences, general designer of the NPO imeni Lavochkin, in collaboration with engineers of other countries. However, the Mars-94 project cannot be called international because the most important and expensive parts and operations (spacecraft, its launching and in-flight work with it) are the responsibility of Russia; thus, Mars-94 is a Russian project with international participation. As of January 1994 all work was proceeding on schedule with a launch planned for October, but last year the funding for the project during the first six months of the year was zero and inflation ate away at the few funds available. During the second half-year funding was normal, but many months were lost and the launch may not take place as scheduled because of the narrow time window. Some Russian specialists are insistent on an October launch, regardless of risk, to prove that the Russian space industry is still alive. Foreign enthusiasts urge a launch this year because they fear that economic and political deterioration in Russia may otherwise terminate the project. Should the Mars-94 project be aborted Russia will lose for decades, perhaps forever, the leading position it enjoys in this field. There is nevertheless every basis for hoping for successful implementation of the project, even if this is delayed to 1996. Figures 6.

Investigation of the Problem of Estimating the Inertial Tensor of the Mir Orbital Station From the Data of Measurements of the Angular Momentum of the Gyrodynes

947Q0154A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 32 No 3, May-Jun 94 [manuscript submitted 2 Jun 93] pp 3-16

[Article by V. V. Sazonov, M. Yu. Belyayev, S. G. Zykov, Institute of Applied Mathematics imeni M. V. Keldysh, Russian Academy of Sciences; NPO Energiya; UDC 629.7]

[FBIS Abstract] Predicting the angular momentum of the gyrodynes of the Mir orbital station with the mathematical models described by Sarychev et al. ("Mathematical modelling of the processes associated with the maintenance of the Mir orbital station's attitude via gyrodynes," KOSMICHESKIYE ISSLEDOVANIYA, 1991, Vol 29, No 2, p 212) requires knowledge of the station's inertial and aerodynamic parameters. Sarychev's models, however, use design values that could contain unacceptable errors. One such error is based on the fact that the inertial tensor, for example, can change when the station's mass is redistributed. But the tensor can be reckoned more precisely by using measurements of the angular momentum of the the gyrodynes made when the station's attitude is being kept constant in an inertial system of coordinates. In the context of linear regression analysis, the researchers here study the possibility of estimating the inertial tensor from measurements of the vector of the angular momentum of the gyrodynes. They show that only four specially selected linear combinations of six inertial tensor components can be estimated when one interval of measurements is being processed. If the angular momentum of the gyrodynes is being measured in a system of principal central axes of inertia, then the differences in its principal moments of inertia can be estimated. When measurements from several time intervals and various station attitudes are processed jointly, the nondiagonal components of the inertial tensor and the differences in its diagonal components can be estimated. References 5 (Russian).

Multi-Impulse Rendezvous Trajectory for Two Spacecraft in a Circular Orbit

947Q0154B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 32 No 3, May-Jun 94 [manuscript submitted 8 Feb 93] pp 33-46

[Article by V. V. Ivashkin, G. G. Raykunov, Institute of Applied Mathematics imeni M. V. Keldysh, Russian Academy of Sciences; UDC 629.197.2]

[FBIS Abstract] Multi-impulse trajectories for a soft rendezvous are studied for two spacecraft initially traveling in the same circular orbit. Constraints are imposed for maneuver time and distance to the center of attraction. Two-impulse, as well as three- and four-impulse maneuvers are studied. The researchers proposed efficient three- and four-impulse profiles for the rendezvous maneuvers, the profiles being simple from the standpoint of flight mechanics, as well as from the standpoint of the running of the solution algorithms on computer. They require little memory or calculation time. In a number of cases, the profiles are more energy-saving than the two-impulse profiles. The energy savings for a geostationary base orbit can be as much as several tens of percent. The choice of two-, three-, or four-impulse profile depends on the initial boundary conditions. Figures 9, references 19: 17 Russian, 2 Western.

Placement of Spacecraft Into Orbit Around Mars With Aerobraking

947Q0154C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 32 No 3, May-Jun 94 [manuscript submitted 21 Feb 91] pp 66-73

[Article by O. A. Nogov, Central Scientific Research Institute of Machine Building; UDC 629.7.015.3]

[FBIS Abstract] As a result of the difficulties associated with the initial segment of motion in the use of aerobraking to place a spacecraft into a Mars-centric orbit, the researchers propose breaking the solution of the problems of navigation and control into two stages. In the first stage, the entry corridor is broken into several segments, and the spacecraft carries a precalculated reference trajectory for each of them. The actual trajectory of the spacecraft is then compared against the reference trajectory, and corrections are made. In the second stage, numerical forecast is used to refine the trajectory angle and compute a new reference trajectory, which is later corrected on the basis of measurements of the banking angle. The navigation algorithm proposed here holds good for an entry corridor of +/-30 km. Because of the expansion of the lower boundary of the corridor, however, the required characteristic velocity V_{char} increases to about 200 m/s. The lowest altitude of the spacecraft above the mean surface of Mars is less than 20 km, which makes preliminary analysis of the surface profile necessary. Figures 1, references 5 (Russian).

Model of the Shielding for the Inhabited Compartments of the Base Module of the Mir Station

947Q0154D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 32 No 3, May-Jun 94 [manuscript submitted 22 Sep 92] pp 115-123

[Article by V. G. Mitrikas, A. N. Martynova, Institute of Biomedical Problems; UDC 533.6.011.8]

[FBIS Abstract] Ensuring radiation safety for cosmonauts requires a knowledge of the screening of crew work stations by structures and equipment. Design should be based on the results of gamma-ray exposure, but the

absence of such data forces researchers to rely on theoretical models like the geometric model described here for the Mir base module. The researchers compare the results of calculations of absorbed doses for the various compartments of Mir against the experimental data for the period surrounding the solar proton event of 19 October 1989. They ascertain the parameters of the model that are in satisfactory agreement with onboard measurements made on 11 and 12 June 1991. The researchers conclude that reliable monitoring and forecast of the dynamics of absorbed doses during power solar proton events require a knowledge of the dynamics of the amplitude of the ring current. The model of the shielding can be refined with a greater number of absorbed-dose measurement points. Figures 3, references 12: 11 Russian, 1 Western.

Measurement of the Background Electrostatic and Variable Electric Fields on the Outer Surface of the Kvant Module of the Mir Orbital Station

947Q0154E Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 32 No 3, May-Jun 94 [manuscript submitted 4 Aug 93] pp 140-142

[Article by N. M. Pushkin, B. A. Mednikov, A. S. Mashkov, O. V. Lapshinova, NPO Energiya; NPO Izmeritelnoy tekhniki; UDC 533.9]

[FBIS Abstract] As a spacecraft travels through the ionosphere, its outer surface acquires an electrical charge as a result of exposure to plasma, solar UV, and fluxes of energetic particles. Electrostatic (or quasistatic) and variable electric fields build up. The strength of those fields are a function of the parameters of the factors acting on the spacecraft and of the material making up the surface of the spacecraft. Field parameters vary considerably with location in relation to velocity vector. In order to study those parameters, researchers mounted Zond-Zaryad gear on the outer surface of the Kvant module. The gear consists of two Zond sensors and a Zaryad converter. The two Zond sensors were mounted on opposite sides of the module along the *z* axis. Electrostatic fields were measured with vibration-type sensing elements, whereas the variable fields were measured with sensing elements that took the form of cavity-type plane antennas. The researchers found that on the front and side surfaces of Kvant, the electrostatic field strength was 0.1-0.5 kW/m. The distribution on the rear surface was somewhat complex, with a strength measuring 10-15 kW/m. For variable electric fields field strength was greatest on the rear surface in terms of amplitude (0.8-1 kW/m). Figures 1, references 5 (Russian).

Baykonur Cosmodrome Facilities Described

957Q0015A Almaty VECHERNIY ALMATY in Russian 5 Oct 94 p 3

[Article by Gennadiy Kononov: "From Baykonur to the Stars"; the first paragraph is an introduction]

[FBIS Translated Text] A good many manned spaceships have been launched from the Baykonur cosmodrome. Yuriy Alekseyevich Gagarin, the first cosmonaut of our planet, headed for the stars from here. After a little more than 30 years the first Kazakh cosmonaut Tokhtar Aubakirov was sent off for work in space. The crew of the 16th space expedition, made up of the ship commander Yuriy Malenchenko and the Kazakh cosmonaut Talgata Musabayeva, the ship's engineer, was launched on 1 July of this year and is still working in orbit.

It is not without reason that the Baykonur cosmodrome has been called a space harbor, but not all know of what this enormous launch complex consists. Today we will endeavor to fill this gap.

The cosmodrome is located in the territory of Kzyl-Orda Oblast. Its administrative and residential center is Leninsk city, whose construction began on 5 May 1955 in a bend of the Syrdarya.

Until August 1991 the cosmodrome was the principal link in the space infrastructure of the former USSR.

It was intended for preparations for and implementation of launches of communication and navigation satellites and those for the detection of launches of rockets into an orbit with an altitude of 20-40 thousand kilometers, topogeodetic and meteorological satellites, as well as space vehicles for scientific and economic purposes, including manned and interplanetary ships and stations.

At the cosmodrome there is unique equipment and apparatus for general technical and special purposes with whose use launch complexes were constructed for the Proton, Voskhod and Zenit space transportation systems.

It also includes industrial facilities for the assembly and testing of rocket-space apparatus and for fabrication and assembly of its individual components.

Here four centers have been established for testing and using space apparatus, as well as one center for the testing of military rocket complexes, constituting part of the cosmodrome system. These centers consist of 9 launch facilities with 15 equipped launch pads for boosters, 11 assembly-test buildings with 34 technical complexes for the prelaunch preparation of boosters and space vehicles and 4 fueling- neutralization stations for boosters and space vehicles.

The cosmodrome industrial complex includes 75 different plants, design bureaus, scientific production associations and complexes, as well as scientific research institutes engaged in the designing, assembly and testing of space vehicles for different purposes, 16 branches of factories, enterprises and organizations engaged in preparation of space equipment, 22 special assembly enterprises and a work sector, institute of biomedical problems, as well as a test teaching-training complex for the prelaunch orientation of cosmonauts.

The Baykonur infrastructure also includes such engineering facilities as a 60-MW thermal electric power plant, 72-MW gas-turbine power train, 600 transformer substations, 32 communication centers and an oxygen- nitrogen plant.

Communication lines and engineering networks include 2 class-1 airfields, 470 kilometers of railroad tracks, 1281 km of roads, 6610 km of electric power lines, 2784 km of communication lines, 360 km of heat supply lines, 1240 km of water supply lines and 430 km of sewage system collectors.

The area of the cosmodrome is 6717 square kilometers and an area of 46 011 square kilometers has been alienated as the area for the falling of separating booster parts.

At the cosmonaut sites there are residential and administrative buildings, hotel and public health facilities. An important place among its structures is occupied by measuring stations, a telemetric system and other space information reception facilities.

The climate at the Baykonur cosmodrome is sharply continental. During winter the air temperature attains 40 degrees below, during the summer 40 degrees above zero.

Leninsk city has a population of about 100 000. The International Space School, an affiliate of the Moscow Aviation Institute, a communications technical school, ten general education schools, two houses of culture, a stadium, swimming pool, motion picture theaters, hotels, as well as cafes, restaurants, bars, sports fields and tennis courts, are present here.

Planned Communications Satellites, Projects at Khrunichev Center Discussed

957Q0010 Moscow MOSKOVSKIYE NOVOSTI in Russian No 46, 9-16 Oct 94 p 30

[Article by Yuriy Ponomarev, under the rubric "Made in Russia": "Commerce in Orbit: The Leadership of the Russian Space Agency (RKA) Hopes That a Step-By-Step Implementation of a Federal Program for the Development of the Space Program Will Help the Sectors to Gradually Move Out of Crisis"; second article is titled "From the Proton to the Angara: The Leading Enterprise in the Domestic Rocket-Space Industry—the State Space Scientific-Production Center (GKNPTs) imeni M. V. Khrunichev—Is Doing Intensive Work to Create Promising Launch Vehicles. Investment in Some of the Programs Is Coming From Western Banks Under Favorable Terms—8-10 Percent Interest Per Annum"; each article is prefaced by introduction in boldface]

[FBIS Translated Text] **The events taking place in the domestic space program give one to hope that the sector is maintaining its scientific-technical potential. One way out of crisis is represented by the proffering of services on the space technologies market, participation in international programs, and cooperation with countries of the West.**

The two unsuccessful dockings between the Progress M-24 transport craft and the Mir orbital station before the successful third attempt drew the public's attention to the plight of the space program. The approval by the government of the "Federal Space Program for Russia Up to the Year 200 and Main Guidelines for Space Activity Up to the Year 2010" went unnoticed. The leadership of the RKA decided not to hold broad discussions of the situation with regard to the federal program or to try to convince the public of the promise inherent in the development of the space program. The experience garnered by advanced-market-economy countries in implementing national and international space programs indicates that space programs—as well as important spheres of state activity such as defense, health care, and education—are, by their very nature, cost-based and can be, to some extent, commercialized.

The economic crisis, which has resulted in a considerable cutback of the scales of science- and production-related activity in the space program, has forced the sector leadership to reexamine many of the earlier positions and to set up new reference points, consolidating them into one program. According to the federal program, top priority is given to tasks directly related to elevating the economic and defense potential of the country. Primary emphasis is to be placed on the development, on a competitive basis, and use of unmanned space vehicles with applied objectives: telecommunications and navigation satellites, as well as space vehicles for weather observations, ecological monitoring, and remote sensing of the Earth.

One circumstance that affected the decision to give top priority to the development of satellite-based communications systems is the enormous need for modern communications systems across the area that stretches from the Baltics to the Pacific Ocean. It should be noted that for now, the launch and operation of communications and television-broadcasting satellites are uniquely promising in commercial terms. However, most Western firms receive profits from, for example, the operation of communications satellites in only the last six to eight months of the usual three-year in-orbit service life of a space vehicle.

According to the federal program, 20 space-communications systems with varying missions and capabilities are expected to be deployed by the year 2000, thereby providing the national economy with a 10- to 15-fold increase in telephone communications, radio relay, and television broadcasting. Plans call for increasing the number of fixed-communication telephone channels to 145,000 from 10,000, and the number of Central Television programs to six from two, with broadcasting across five time zones.

The long-term plans of the RKA include the creation and launch into orbit of a whole series of new communications satellites that the Krasnoyarsk NPO of Applied

Mechanics has already started developing—the Ekspress-M, Gals-R, Gonets, Arkos, and Mayak satellites. The S. A. Lavochkin NPO has already begun work on the Zerkalo and Kupon, and the S. P. Korolev NPO Energiya has started developing the Yamal and the Signal satellites. The money for financing those expensive projects is expected to come from the state budget and, partially, from commercial-structure investment. Of course, the implementation of the RKA's long-term program depends on the country's economic condition.

In 1992, the Krasnoyarsk NPO of Applied Mechanics, the state enterprise Kosmicheskaya svyaz [Space Communications], the Scientific Research Institute of Space Instrument-Making, the Scientific Research Institute of Radio Engineering, and the Vostok Bank formed the joint-stock company Informkosmos in order to offer Russian communications satellites to foreign firms. The money received from commercial activity goes to scientific-technical work.

A very paradoxical situation has come about: the country's leading space firms are engaged in developing new satellite-communications systems, but domestic consumers are not in a position to use the existing systems to the full extent because of the lack of financial resources. Even the Russian military are earning money on communications satellites: a considerable number of shortwave channels on satellites belonging to the Russian Federation Ministry of Defense are now being allotted to commercial users. When the Russian troops left the countries of Eastern Europe, lost forever were the military satellite-communications stations there that could have been used for commercial purposes.

The market economy of any industrially developed country cannot function normally without modern communications systems. And although most of the domestic commercial organizations that need high-speed, reliable communications systems cannot right now finance large-scale projects whose implementation time exceeds 18 months, a large number of investors in the near future can attract investment in global satellite-communications systems as inflation subsides and the risk associated with production-related infusions into science-intensive sectors diminishes.

MOSKOVSKIYE NOVOSTI File

To date, there are 172 domestic space vehicles in orbit, and the overwhelming majority of them are operating well. Over the last eight months, nearly 30 new space vehicles were launched. The Mir orbital complex has been in operation for more than eight years. The operation of the Russian satellites and manned vehicles is supported by a large ground system, which includes two cosmodromes (Plesetsk and Baykonur), three flight control centers, and 15 tracking stations.

Consolidating their efforts, the leading industrially developed countries will be able to build a common "space house" in orbit and make it a place for creating new peaceful technologies. The advances achieved in Russian science and technology can influence progress in the exploration of space and can have a positive effect on the solution of problems on the ground.

One profitable area in the space program involves the offering of launch vehicles for lifting commercial payloads, primarily communications satellites. Russia's entry into that market for space technologies, where the competition is very rough, was helped partially by the accident in January 1993 that involved the European Ariane 44LP launch vehicle, which resulted in the loss of two communications satellites valued at a total of $250 million. In the same year, the American firm Motorola and the M. V. Khrunichev State Space Scientific-Production Center [GKNPTs] concluded an agreement regarding the use of the Proton booster rocket to launch 21 of 66 low-orbit satellites of the Iridium global communications system. Over the past two years, GKNPTs has invested $70,000 from its own profits into the Iridium project. In December 1992, the Russian-American joint venture Lockheed-Khrunichev-Energiya was created to implement commercial launches of the Proton rocket.

In 1994, another joint venture was created, with the German firm Deutsche Aerospace. The Russian-German joint venture, which still doesn't have an official name, will offer services involving the commercial use of lightweight Rokot boosters, which will be used to place satellites weighing 2 tons or less into low orbits.

Thanks to successful commercial production activity, the Center's leadership has signed a number of contracts with foreign partners for a total of nearly $1 billion, with the contracts slated to be implemented between 1994 and 1998.

In August of this year, there was an official announcement that the M. V. Khrunichev Space Center has been named the head enterprise for the creation of the new, heavy-lift launch vehicle Angara, which will be used to place payloads weighing up to 27 tons into orbits 200 km high. Ground tests of the new rocket complex are slated for 1998-1999, and the first launch is to take place between 2000 and 2002.

Difficult economic conditions have forced the Center to develop several areas: in addition to the subdivisions that develop and manufacture space vehicles, an experimental design bureau has been created, as has production of aviation equipment. In 1995, the Khrunichev Center plans to begin production of the five-seater T-411 (AERO) aircraft. The Center is also producing consumer goods and is developing intricate medical equipment. Whether such a variety of activity will be just a temporary phase for the leading rocket-space firm, only time will tell. The logic underlying the course of events shows that the experience garnered by Russia as a result of more than 30 years of space exploration, as well as the considerable scientific-technical stockpile of products, coupled with Western investment, could be of mutual benefit.

MOSKOVSKIYE NOVOSTI File

The Rokot launch vehicle, with the Briz upper stage, was developed as a modification of the converted RS-18 (SS-19) two-stage ballistic missile that was taken off line in the military arsenal, in accordance with the agreement on scaling back and limitation of strategic offensive arms.

Russian Booster To Be Used To Launch Swedish Satellite

957Q0009 Moscow SEGODNYA in Russian 12 Oct 94 p 11

[Article with no byline: "Omsk Booster Kosmos for Swedish Astrid Satellite"]

[FBIS Translated Text] The Omsk Aerospace Association Polet has begun developing the technical documentation for using a booster it manufactures, the Kosmos, to launch the Swedish Astrid satellite (the mass of the payload to be placed in orbit will be 1,400 kg), reported a division deputy chief of the experimental design bureau Polet, Vasiliy Gorlov. A contract between the Polet Association and the Swedish Space Corporation was signed in early October. A preliminary agreement on its conclusion was reached in September at the Farnborough air show (in Great Britain). The worth of the contract was not publicized, but according to unofficial sources, it is estimated to be $10-12 million. The liftoff of the Kosmos and the Astrid satellite is slated to take place at the Plesetsk cosmodrome before the end of this year.

Russian Shipbuilders Propose Floating Cosmodrome

957Q0007A Moscow SEGODNYA in Russian 20 Oct 94 p 9

[Article by Vadim Tyagniryadno: "From a Ship Into Orbit"]

[FBIS Translated Text] An extremely original solution of the problems arising because the key cosmodrome of the USSR is now located outside the borders of Russia has been proposed by the scientists of the A. N. Krylov Central Scientific Research Institute in collaboration with colleagues from several St. Petersburg and Moscow scientific research institutes. They feel that "space rockets can be launched from special ships."

The Krylov Central Scientific Research Institute, which is the leading scientific research center of Russia in the shipbuilding field, using its enormous experimental base, has carried out thorough preliminary development work on the unique project, and according to Valentin Pashin, its director, it has been demonstrated that the idea of installing launch pads for spaceships on surface ships is in no way fantastic and its realization is entirely within the capabilities of modern Russian science and industry. It has been calculated that in order to construct a floating platform it is sufficient to build a ship about 250 m long with a displacement of 60-70 thousand tons. Scientists assert that they have at their disposition means which will stabilize the ship and will enable it to withstand the loads arising during the launch of a spaceship. In such a case the expenditures will be less than for an ordinary launch. In addition, a mobile launch platform will make possible maximum use of the Earth's configuration—it will be possible to dispatch the ship into the equatorial zone for the launch of rockets.

Mister Pashin feels that the first launch platform could already set out for sea after four years: the initiators of the idea are ready to carry out final development of the project over the course of the year. They feel that ship construction will take another three years. As stated by Valentin Pashin, the Ministry of Defense and other departments to which scientists have turned in general have approved the project. However, the prospects for launch platforms for use at sea remain unclear: the Central Scientific Research Institute and its collaborators have no money for independent development work on the project and for the time being they are not succeeding in getting money from other departments.

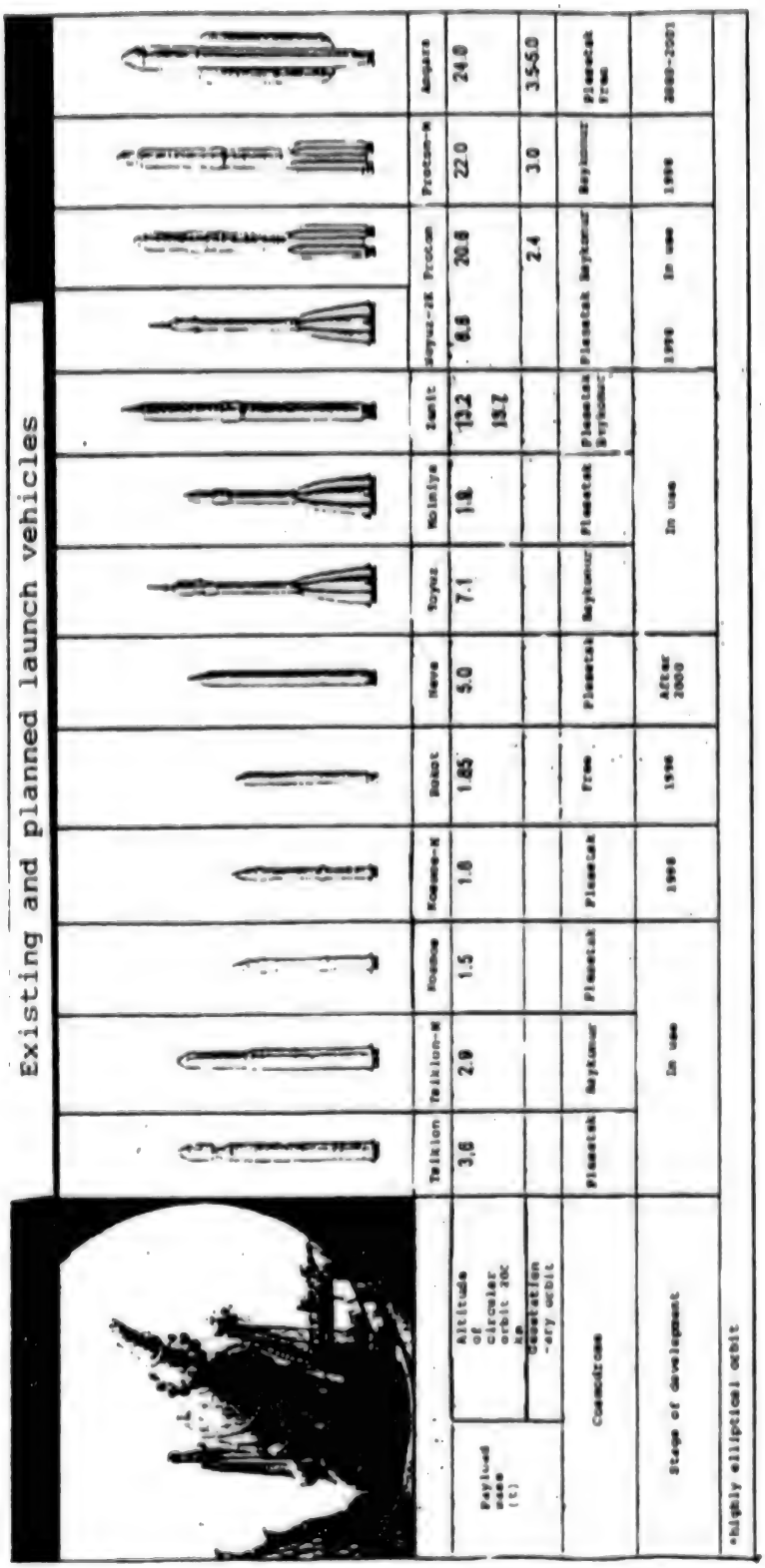
New Uses for Zenit Rocket

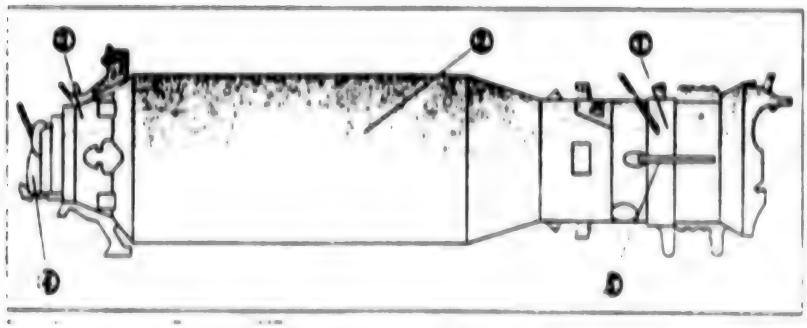
957Q0023A Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 4 Nov 94 p 39

[Article by Christian Lardier: "New Uses for Zenit Rocket"]

[FBIS Translated Text] The Zenit rocket is going to launch a Resource-03 remote sensing satellite (1.9 metric tons) into polar orbit (inclination of 98 degrees) for the first time in November or December. With an additional payload: the Safir-R microsatellite produced by the German firm OHB [expansion not given]. This marks the start of a wider utilization of the rocket in question, which since 1985 has been used only for fourth-generation military electronic listening satellites and sixth-generation Kuban reconnaissance satellites (see AIR & COSMOS No. 1485).

The two-stage Zenit-2 version is currently being launched from Platform No. 45L at Baikonur. Platform No. 45P was destroyed during the launch failure on 4 October 1990, when the first-stage engine exploded after five seconds of flight and the rocket fell back onto the platform from a height of 70 meters. The second failure, on 30 August 1991, occurred when the second stage exploded during the third minute of flight. The third and last failure, on 5 February 1992, was reportedly also caused by the second stage. Since then, Russia has been launching from two to three Zenits per year. It will use the Zenith to place second-generation Ocean-O satellites (6.7 metric tons) in orbit beginning in mid-1995 and then the Ukrainian Sich-2 satellite in 1998. In addition, the recoverable satellites Bion, Photon, and Resource-F are to be replaced by civilian versions of the Kuban (Nika-B, Nika-T, and Nika-K (nine metric tons) respectively). A satellite for studying cosmic rays (Nika-E) is





The 13.3-metric-ton Progress-MT cargo vessel will be launched by Zenit. Components of the Progress-MT: 1. Service module—2. Cargo compartment—3. Docking area—4. Androgynous link-up part—5. Solar panels.

also under consideration. But the Zenit will be used above all to provide logistic support for the Alpha orbital station beginning in 1998. Four flights will be required to set up the universal link-up system and the NEP [expansion not given] energy platform. It will also launch the 13.3-metric-ton cargo vessel Progress-MT beginning in November 1998.

LANCEMENTS DE LA FUSEE ZENITH

DATE	SATELLITE	INCLINAISON (1)	MISSION
13/04/85	-	-	Suborbital
21/06/85	-	-	Suborbital
22/10/85	Cosmos-1697	71°	Ecoute électron.
28/12/85	Cosmos-1714	71° (2)	Ecoute électron.
30/07/86	Cosmos-1767	65°	Reconnaissance
22/10/86	Cosmos-1786	65° (3)	Echec
14/02/87	Cosmos-1820	65°	Reconnaissance
18/03/87	Cosmos-1833	71°	Ecoute électron.
13/05/87	Cosmos-1844	71° (2)	Ecoute électron.
01/08/87	Cosmos-1871	97°	Reconnaissance
28/08/87	Cosmos-1873	65°	Reconnaissance
15/05/88	Cosmos-1943	71°	Ecoute électron.
23/11/88	Cosmos-1980	71° (2)	Ecoute électron.
22/05/90	Cosmos-2082	71°	Ecoute électron.
04/10/90	-	-	Echec
30/08/91	-	- (3)	Echec
05/02/92	-	-	Echec
17/11/92	Cosmos-2219	71°	Ecoute électron.
25/12/92	Cosmos-2227	71°	Ecoute électron.
26/03/93	Cosmos-2237	71°	Ecoute électron.
16/09/93	Cosmos-2253	71° (2)	Ecoute électron.
23/04/94	Cosmos-2278	71°	Ecoute électron.
26/08/94	Cosmos-2290	65°	Reconnaissance

Zenit Rocket Launches

Key:—1. Inclination—2. Electronic listening—3. Failed

Platform No. 35 at Plesetsk will be completed in 1997, and the Zenit-3 version with upper stage 11C851 (Block D) will be launched from Platform No. 45P at Baikonur in mid-1996. That three-stage version makes it possible to place two metric tons in geostationary orbit. The attempts to launch Zenit-3 from Australia or New Guinea came to nothing.

Zenit is being built by KB Yuzhnoye and the YUZHMACH factory in Dniepropetrovsk (Ukraine). But the RD-170 and RD-120 engines are being supplied by KB ENERGOMACH in Moscow and the Poliot factory in Omsk (Russia). The steering system is being produced by design bureaus in Moscow and factories in Kharkov and Kiev, while the launch complex is being supplied by KB Transportation Machines in Moscow. Of the 36 firms involved in building Zenit, about 40 percent are in Ukraine, and the rest are in Russia. For their part, the Ukrainians are considering a Zenit-M4 version fitted with a third and fourth stage, both with storable propellants (N_2O_4-UDMH [unsymmetrical dimethyl hydrazine]). An airborne version known as Svitiaz is being considered for 1998. To be carried on the Mriya aircraft (built by OKB Antonov in Kiev), it will permit launches from Ukraine, which lacks a cosmodrome. It will be able to place nine metric tons in low orbit or one metric ton in geostationary orbit. Following the example of KB Makeiev's Priboi launcher (see AIR & COSMOS No. 1484 a shipborne version is also being designed by NPO Energya, KB Yuzhnoye, and the U.S. firm Boeing. The Zenit reportedly will be shipped to the United States for launching from international waters. Use of Zenit for the Alpha station or by Boeing depends, however, on Ukraine's compliance with the START disarmament agreements. But so far, marketing of the Zenit has not been a success for either the Russians or the Ukrainians.

Idea for Space Defense Project Described

957Q0027A Novosibirsk VECHERNIY NOVOSIBIRSK in Russian 2 Dec 94 p 6

[Interview between Yuriy Voronchikhin, VN correspondent, and G. A. Kiselev, B. P. Kryukov and Yu. A. Vedernikov: "Space Defense of the Earth Begins From the Ural and Siberia. This Project May Become the Equal of the Projects for Conquest of the Moon and Mars"; the first paragraph is an introduction]

[FBIS Translated Text] During the past week VECHERNIY NOVOSIBIRSK told about the international conference on "Problems of Defense of the Earth Against Collision With Dangerous Space Bodies (SPE-94)." Today, at the request of readers interested in this subject, we are continuing the theme. Our correspondent met with German Aleksandrovich Kiselev, academician of the Russian Artillery-Rocket Academy (RARAN), doctor of technical sciences, Boris Petrovich Kryukov, doctor of physical and mathematical sciences, and Yuriy Aleksandrovich Vedernikov, candidate of physical and mathematical sciences.

Yuriy Voronchikhin: All you three participated in the SPE-94 conference. What particularly surprised you? What is your place in the series of studies on defending the Earth against meteorites?

German Kiselev: With the appearance of the widely spaced network of nuclear power plants the risk from a catastrophic collision between our planet and a small meteorite is increasing. Prior to this, according to David Morrison, a NASA representative, the probability of an encounter between the Earth and a dangerous space body (DSB) was equal to the probability that an individual person would be in an aircraft accident. Accordingly, the declaration by Edward Teller that the time has come for using nuclear weapons in order to repulse comet-asteroid attacks becomes understandable. His address was supported by computations and the spirited words of Samvel Grigoryan and Boris Litvinov, corresponding members Russian Academy of Sciences. Ricocheting of an asteroid 10 km in diameter would require a charge with a power of 100 megatons, for all practical purposes realized in the form of an aerial bomb by the Snezhinsk Nuclear Center.

My attention was drawn greatly to the problems involved in the designing and use of long-range rocket interceptors of DSB with nuclear devices. The Miass Rocket Center, in a series of well-reasoned reports, indicated that already before the end of the current millennium it will be possible to finalize the design work for the vehicle for delivery of such a large charge over interplanetary distances. Pavel Kryukov, a representative of the Moscow Central Scientific Research Institute for Machine Building, as a missile alternative presented a project for a ballistic system for antiasteroid defense based on a combination of guns. Such a vertically based gas-cumulative gun with a caliber 0.5 m and 2000 m in length would shoot graphite shells weighing 200 kg at a velocity 7 km/s.

Boris Kryukov: If you take two identical guns such as mentioned at the conference by my Moscow colleague with the last same name and they are used in propelling kilogram charges toward one another, they can ensure a gas-dynamical initiation of thermonuclear fusion. The program of experiments in a turbocumulative accelerator included experiments with them involving propulsion of dense deuterium jets up to 300 km/s with an energy yield up to 10 GJ. After such figures Vladimir Titov, academician of the Russian Academy of Sciences and the Russian Artillery-Rocket Academy, expressed considerations on the discovery of high-velocity collisions new for mathematical simulation specialists. In this connection presentation of a display report by the Siberian mathematician Vladimir Shchepanovskiy showing a gas-dynamical design of stellate penetrators was highly effective. A motto for his communication and that of Yuriy Aleksandrovich in application to small celestial bodies could be the phrase: "To the stars—through the stars!"

Yuriy Vedernikov: In the section "Tunguska Meteorite" I, together with Boris Petrovich, presented a review of their three reports.

In the hall where the plenary sessions were held, at that time Teller, 86 years old, the same age as the Tunguska event, supporting himself on his legendary cane, listened attentively to report after report, becoming enlivened with the presentation of new communications on the July "hits" of Jupiter by the Shoemaker-Levy-9 comet. American, Russian and Ukrainian astrophysicists presented mutually supplementing results of telescopic measurements in Jupiter-94. Surges of plasma from "craters," similar to solar prominences, were discovered. The temperature dropped by 20 degrees and this has already persisted for the fourth month! A communication by a team of authors headed by Mikhail Lavrentyev, academician of the Russian Academy of Sciences, was sensational due to its physical novelty. Using the spinor properties of special minerals they obtained signals from a series of impacts on Jupiter 43 minutes sooner than the Americans did by means of light signals from the Hubble space telescope.

Yuriy Voronchikhin: In your opinion, what changes do you foresee for yourself and Russia after the holding of the Chelyabinsk-70 antiasteroid conference?

Yuriy Vedernikov: The initiators of the South Ural conference, Professor Vadim Simonenko, the eminent designer Viktor Volkov, and your obedient servant, also glanced forward at the funding of antiasteroid research. We pondered the fact that on the eve of the Jovian cataclysm what is still a regional fund, "Space Defense," was registered in Chelyabinsk, with prospects for it gaining an international status in late 1994-early 1995. Plans call for establishing an ecologic almanac "Space

Shield of the Earth" in the Russian and English languages. The latter will be set up in collaboration with the editorial board of the journal SOVERSHENNO SECRETNO (Top Secret), telling about secret cities such as Snezhinsk which have never been plotted on the maps of our country.

Shoving off from the historical springboard of Russian space activity, an enterprising group of scientists and designers participating in the work of SPE-94 advanced a national idea of universal scale. They clearly outlined the role of Russia as the driving force in the space defense of the Earth. The future of our immune-deficit planet is now dependent precisely on the state of the creative spirit, strong resolution and mentality of the principal Slavic country.

German Kiselev: After the Chelyabinsk-70 conference I attended a departmental session of the RARAN on dual technologies. We discussed matters related to preparations for the general meeting of the Russian Artillery-Rocket Academy at which its new members will be elected and the first outlines of government funding of development work in the deeply depressed military-industrial complex will be examined. All this is tied in with the general direction of the SPE-94 resolution and Russian space activity. The romantic notion of participation in a great national undertaking completely open to the public view is appearing.

Boris Kryukov: Personally I am not waiting for money from our government for an antiasteroid program. I am laying my hopes solely on sponsorship, on the establishment of the "Space Defense" fund and its Novosibirsk affiliate.

It appears that conversion problems in relation to planetary and human ecology correspond well to the spirit of Russian space activity. It is precisely in this direction which one must seek an escape from the prevailing general breakdown in the country. However strange it may seem, but it may be that RARAN (president Vladimir Kireyev) in the very near future may become a guarantee of Russian rebirth.

Yuriy Voronchikhin: Has the Snezhinsk forum become a scientific sensation? And in general, what do you understand by a "sensation" in science and in the press?

Boris Kryukov: An unanticipated surprise for me was a communication by Tom Gehrels on publication of a book on defense against asteroids. I was represented in it as one of the coauthors of a long article on defense against meteorites. To be sure, however, a sensation was caused by the discussion between the "dove" Gehrels and the "hawk" Teller. In our country scientists have unlearned how to dispute so uncompromisingly.

German Kiselev: The holding of such a conference, particularly in what earlier had been a completely closed city, is already in itself a sociopolitical sensation. This is akin to the falling of a small Berlin wall. The scientific-technical significance of SPE-94 is characterized by the timeliness and large-scale nature of the problems to be solved. I would like to believe that in its further development it will acquire the status of the ecology conference held in Rio de Janeiro (1992) under the aegis of the UN. In purely scientific respects this represents, to be sure, the turning of a new page in mathematical simulation of detection, aiming at and hitting dangerous space bodies—DSB. It is true that such studies bit by bit were carried out behind the walls of superclosed cities and have become frankly revealed only for journalists. I would not be surprised if the project for antiasteroid defense of the Earth becomes the equal of projects for conquest of the Moon and landing on Mars.

Cosmonaut Airs Views on Mir, Space Program

957Q0029A Moscow SEGODNYA in Russian 8 Dec 94 p 9

[Interview with cosmonaut Yuriy Malenchenko by Roman Vershillo: "The Man Who Saved the Mir and Progress. Yuriy Malenchenko Does Not Forget the Motto 'You Can't Count on Anything'"; the first paragraph is a biographical sketch of Yu. I. Malenchenko]

[Text] Yuriy Ivanovich Malenchenko. Hero of Russia, awarded three medals. Born 22 December 1961 at Svetlovodsk, Kirovograd Oblast. Ukrainian. In 1983 graduated from the Kharkov Higher Military Aviation School for Pilots. In 1993 (by correspondence) graduated from the N. Ye. Zhukovskiy Military Air Engineering Academy. In the Armed Forces since 1 August 1979, lieutenant colonel. Appointed to the Cosmonaut Training Center in October 1987. Military airman class 3; 830 hours in L-39, MiG-21 and MiG-23 aircraft. Made more than 150 parachute jumps of different degrees of complexity. Is married and has a son.

The inertial force of space heroism has played a cruel joke on Yuriy Malenchenko, being at the epicenter of the events which in August of this year threatened the Russian space program. For some reason or another we have gotten out of the habit of thinking that in actuality the prestige of Russia, not to mention the fate of the billions of rubles in contracts, is dependent on our cosmonauts. Return to reality was unexpected and pleasant. It was found that by no means was it only by tradition that the stars of heroes are handed out. For the first time in many years it was possible to see the man enshrouded in a space suit and to view the face beneath the helmet.

We recall that on 2 September a third attempt was made to dock the Mir space station and the Progress cargo ship. The first two unsuccessful docking attempts were made in an automatic mode. The Flight Control Center was left no other recourse than to entrust this highly complex operation to man. The responsibility rested on the shoulders of the crew commander Yuriy Malenchenko. And he performed his task calmly and

with assurance. But after all, he was left only one more chance. In the event of a failure the Progress, having expended all the fuel needed for reaching the docking point, would be out of range and sooner or later its fragments would tumble to the Earth in one region or another. The station crew would have to abandon the Mir at once and the behavior of the complex would become unpredictable. In addition, the orbital complex is a trump card in the game with NASA, which in cooperation with Russia intends to build the Alpha international orbital station.

It goes without saying that Yuriy Malenchenko was trained to work in a manual mode. But it has already developed in our cosmonautics that there is more trust in automatic systems than in man. But in actuality everything happened despite these traditions.

SEGODNYA personnel met in our editorial offices with Hero of Russia Yuriy Malenchenko, the most illustrious figure of modern Russian cosmonautics, the central personage of a number of articles in the newspaper SEGODNYA, upon completion of the postflight quarantine period.

Vershillo: Your actions during the third attempt to dock the Mir station and the Progress cargo ship suggest that there was more excitement on the ground than in orbit. Did you sense this to some degree?

Malenchenko: At the Flight Control Center an alarm was actually sounded, but we did not feel the impact of this in space. Although I myself fully understood the great importance attached to this docking.

During the last several days the results have been summarized many times and there have been many reports. Specialists of the Energiya Russian Space Corporation and the Flight Control Center acknowledge that everything hung by a thread. Now there are no attempts to conceal this.

Vershillo: What did the Mir station look like to you; after all it is already considered to be "a very old lady."

Malenchenko: While on Earth I had some idea of what the Mir would look like. My ideas were based on the revelations of those who had flown to the station and communication contacts with the station. I had all the information on repair work to the Mir and about existing problems. To tell you the truth, I anticipated worse. Nevertheless, the station is already eight years old and soon will be nine. But initially it was designed for only five years of operation. But I was convinced that it was in excellent condition. Outwardly the complex is very clean and neat, all the panels are intact and in the space behind the panels there are no traces of corrosion. Perhaps there were some traces of deposits, but this is natural for a vehicle remaining so long in space. They will scarcely exert an influence on station longevity.

The station is beautifully constructed and the work places are excellently designed. It goes with saying that it is impossible to work on it forever, even by replacing some units and assemblies. Moreover, the joints have their safety limits. According to prevailing plans, work on the Mir will continue to 1997.

The radiation background aboard is not increasing; on the contrary, there are places in the station where it has even decreased. Valeriy Polyakov, for example, worked with "800 units"—these are large storage batteries—and in his cabin the radiation background was approximately one-third lower than, let's say, in mine.

Vershillo: What were your most "acute" sensations other than during the famed docking?

Malenchenko: I had been told many times about the descent from orbit to the Earth, but in actuality, as it turned out, it was somewhat special. At first everything went off very routinely. The engine was shut down and the separation of the stages occurred. The work and service modules were separated and slightly rotating, we began a descent. The atmosphere appeared and the g-force began. The g-force is usually as much as 4 g, for us it was 3. For a flier 3 g is trifling. I myself entered the cosmonaut detachment from fighter aircraft where we experienced both 5 and 6 and 9 g. But after such a prolonged flight it was hard to bear. Not even my safety belt was yet buckled. While Ulf buckled up I helped Talgat, fussed about and didn't get to my own buckling. The g-force hit and I could not raise my arm. I figured that I would buckle up after the parachute was deployed because the most important thing is to be secured when landing. But when the parachute was deployed we began to shake and it seemed like I would fly from my seat right then and there. My elbows were resting on the adjacent seats and for a minute I could not even see what was written on the display panel before my eyes.

The landing was very hard and I think that if the impact had been just a little stronger there is no knowing how everything would have turned out. Like a blow on the head with a piece of firewood—such was the sensation.

Vershillo: It was very flattering for us to learn that they delivered into orbit the newspaper SEGODNYA with the article "Russian Space Program in Hands of Lieutenant Colonel Malenchenko." But, in general, up there how much information is available concerning matters back here?

Malenchenko: When Aleksandr Viktorenko flew into orbit he said to me: "Look, Yuriy, I brought you a gift" and he handed me the newspaper SEGODNYA. This was a pleasant surprise and in general an exception. Information is transmitted into orbit very selectively, making its way through a great many filters. Every word is screened in order that there be nothing superfluous. They provide us news by television, but as a recording, and only sound at that, when there is free time and a free communication channel. The "excerpt" from television and radio is the sole possibility for a cosmonaut to feel what it is to live on Earth. It has happened that for weeks

nothing was received, so some suspicion even began to creep in that something or other was going on back there on the ground.

Twice during the expedition there were TV contacts with our families, approximately for an hour each, but there was two-directional communication only once. It was more frequently possible to talk with relatives by telephone.

Vershillo: Is there a library in the station?

Malenchenko: There are approximately a hundred books, newspapers and journals in the shipboard library. It's customary to read before sleep. Among the books there are even "Akvarium," "Ledokol" and "Den-M" by Viktor Suvorov. The literature and videofilms are selected by a special psychological subdivision at the Flight Control Center.

Vershillo: What new is awaiting the station from which you recently parted?

Malenchenko: The coming year in space will be a very serious one. First, the acceptance of a new module in the complex. For this purpose the solar cells must be transferred from one module to another. It is necessary that the panels be folded and unfolded. If something doesn't go right they must be ejected into open space. The complex would lose part of its electric power. It is difficult to predict how the station would behave in this event. In general the power problem is now the most important. We chanced to experience a total loss of electricity: the lights went out and the instruments were cut off.

Vershillo: And what are your own plans?

Malenchenko: Now I am going to a sanatorium in Sochi for approximately two weeks. This is necessary for postflight recovery. I myself feel no unpleasant aftereffects, but the doctors see a change in blood composition, etc. Then in January I will travel to a resort in Italy, also for rest.

Vershillo: Space is becoming more and more commercialized. Do you feel that this has an impact on you?

Malenchenko: I have already been in the cosmonaut detachment for eight years and earlier there was not such a commercial load on the cosmonaut. But now I, for example, have sensed that there are a great many commercial agreements on which you are working and this undoubtedly is a great responsibility. I myself am working under contract with the Energiya Russian Space Corporation. It, in turn, is signing contracts with a great many companies, with the European Space Agency and the Kazakhstan National Space Agency. With NASA, for example, a contract for 400 million dollars.

The cosmonaut has in his hands the product of entire bodies of workers and as it sometimes happens, performance of a contract is dependent on you personally.

After the successful docking the cost of the contract with me and Musabayev increased by 25%. Before this we received 100 dollars per day during work in the station. I spent a total of 126 days in the Mir. Additional pay was received for the approach and docking. And a space walk "costs" 1000 dollars.

Vershillo: What is the probability that you will fly into space again?

Malenchenko: There is a plan for flights right up to 1996. I am not included. However, during flight training I saw possibly five plans. They were constantly changed in one way or another. Vladimir Lyakhov had a saying which can serve as a motto for the cosmonaut: "You can't count on anything."

Poor Prospects Seen for Conversion, Penetration of International Space Market

947Q0174A Moscow LITERATURNAYA GAZETA in Russian No 38, 21 Sep 94 p 10

[Article by German Lomanov: "Space Attractions. Today Russia Has the Smallest Share of the Space Market—Three Percent. Even China Has More"]

[FBIS Translated Text] It is a clear sunny day at Baykonur. The specialists and journalists gathering at the observation point, with strained eyes, tensely are looking into the blinding sky in the direction from whence the Buran, coming in for a landing, should appear. Their restlessness is understandable: the flight of our first "shuttle" was controlled by an automatic system. However clever a machine may be, it's no match for an experienced pilot. Is it possible to bring down on the landing strip a 100-ton monster which is traveling at the speed of a jet fighter? But right now we see the swiftly descending Buran—clean touchdown, swift roll down the runway and stop.

At that time there were enthusiastic articles in the press, including in the American press: to be sure, in the launch of their "shuttle" the Russians lagged 10 years behind us, but would you believe that they were able to land in an unmanned mode? With their antediluvian electronic system...?

Scientific work stumbles forward

It is a clear sunny evening in Moscow. The specialists and journalists gathering at the Scientific Research Institute for Automation and Instrument Making are waiting the beginning of a ceremony for the opening of the MosMed plant, a joint Russian-American enterprise. It transpired even with some pomp—a ribbon was cut by Mstislav Rostropovich, in this case attempting to say something aphoristic:

"Earlier these plants worked on the annihilation of people, and now they will work here in the interests of their health."

The director was in error: they did not work for war at these work sites. Unpretentious American production of surgical clamps has been set up at the very same sites at which the unique control complex for the Buran was perfected. The apotheosis of Russian cosmonautics, now resting on a pedestal in the Gorkiy Central Park for Culture and Rest.

Feliks Lomako, plant director, said to me sadly: "But what can you do? Although there will be some money, we owe suppliers about 700 million rubles and the Ministry of Defense, in turn, owes us approximately 600 million and is unable to pay."

I do not know what pictures flashed in the mind of Valentin Stepanov, deputy chairman of the State Committee for the Defense Industry, in charge of space, at the MosMed inaugural opening, but later at a banquet at the Metropol he gloomily stated:

"We go forward at American expense and once again Russia is providing no money for the work."

The story of MosMed is by no means an exception: rather it is the rule, from that code of rules by which the ideologists of our spontaneous, chaotic conversion play. For example, the NPO imeni S. A. Lavochkin has begun to produce apparatus for the sterilization of endoscopes and preparation of disinfecting solutions. This is all for the good: in most gastroenterological clinics the nurses simply wash endoscopes over a sink. There is scarcely any need to explain how great in this case is the risk of contamination from AIDS or hepatitis. But what explains why this very small detail should concern a company in whose work experience there are at least seven pioneering world attainments (first artificial lunar satellite, first soft landing on the moon, the lunokhod, which was famous in its time, the return of lunar ground to the Earth, the first Venusian satellite, soft landing on the Morning Star and Mars)? It goes without saying that even a microscope can be used to drive in nails, but only when there is a very great need for it.

Meanwhile, when a changeover to the market began, the NPO imeni S. A. Lavochkin worked out a number of major commercial projects in the satellite communication and space industry fields. However, they were not included in the conversion programs and the NPO did not receive even a single kopeck of state money so necessary for restructuring. Attempts were made to carry out conversion on a commercial basis. Some things got done, but things went listlessly. Take at least the Bankir project, now extremely necessary for our financial system. Its purpose is to introduce a paper-free technology into banking transactions. It is well known that in Russia this system is antiquated—money spends days, even weeks, in moving from one account to another, from one city to another. The enormous amount of capital taken out of circulation, traveling willy-nilly, during this time does no work, inflicting indirect losses on its owners, although it could yield a profit. In our country no one has calculated the losses, but their scale can be visualized from the estimates of British experts: a changeover from paper to electronic transactions would be equivalent to an increase in the GNP by 5-7%.

The NPO imeni S. A. Lavochkin is responsible for the space portion of the project. It is proposed that four Kupon satellites be put into a geostationary orbit. The heart of the project is a repeater outfitted with a phased antenna array. It directs earthward 16 radio rays, each of which on the ground surface covers an area 1200-1500 km in diameter and which carries enormous volumes of information.

Moreover, the electronic system for antenna control makes possible instantaneous redirecting of the ray from one region to another. Let's say that in the European part of the Russian Federation it is still night, but the Far East

is already working: several rays can be directed there in order to increase the capabilities of the system precisely in that region. The Bankir is capable of servicing more than 40 thousand subscribers; all the financial transactions are made in an on-line mode, that is to say, instantaneously. The signal is sent not only from one bank to another, but also to the Central Bank, this making it possible to have constant monitoring of the entire turnover of money in Russia. For the time being there are no such satellite systems abroad.

The launch of the first Kupon satellite was planned for early 1994, but the Global Information Systems joint-stock company financing the project during the past year was unable to provide the necessary amount of capital. Now the NPO has proceeded to construction of the first satellite; the company has already acquired the Proton booster for its launching from the M. V. Khrunichev State Center. Judging from unofficial information, the Central Bank, holding 17% of the corporate capital of the GIS joint-stock company, intended to assume full financing of the space system. However, the directors do not have full assurance that the company will begin to clip stock coupons even in 1995.

After a sumptuous feast, no more than a piece of bread

The recent decision of the government to transfer 38 companies from the State Committee for the Defense Industry to the management of the Russian Space Agency (among them such well-known companies as the NPO imeni S. A. Lavochkin, the Scientific Research Institute for Space Instrument Making, the NPO of Applied Mechanics, the Samara plant Progress and the Voronezh Machine Building Plant) has generated no special euphoria either among their managers or among their specialists. Although these scientific research institutes, design bureaus and enterprises have retained a governmental status, there are few who believe that they will receive budgeted funding in full amount and on time.

Recent years, marked by the imprint of degradation of the once powerful branch, convinced the space elite of the futility of hopes for serious state support. The unstable situation is forcing aerospace companies well known throughout the world to find some way to integrate into a market economy, insofar as possible to direct their activity into commercial channels. And whereas initially commercialization was limited to random, scattered contracts and projects, not providing material for analysis, now it is already possible to speak of definite tendencies. To be sure, it is necessary to forget about former splendid funding from the state budget and now the talk is simply about attempts to earn one's daily bread.

In actuality, among all the Russian companies it is only the M. V. Khrunichev State Center which has a chance of occupying a more or less substantial niche in the world commercial launches market. But it has a special position in the branch—it is the owner of the famed Proton, one of the most reliable boosters. In addition, this is our sole heavy booster capable of putting communication satellites immediately into a geostationary orbit.

As one of the first, the M. V. Khrunichev plant signed a contract for 200 million dollars with the American Motorola Company for three Proton launches (launching of communication satellites into a low orbit) and organized with the Lockheed corporation a joint enterprise for sale of launches of the "500" in the world market. This will provide our company with an annual income of 60-100 million dollars—this still is not prosperity, but still is rather significant. We will hope that Anatoliy Kiselev, the general director of the State Center, will be able to carry out his plans and earn at least a piece of bread, even if it be without butter.

In my opinion it will be much more difficult for the developers and builders of other boosters to enter the world launch market, although they do have their possibilities. The Start and Start-1 mobile rocket complexes developed by the Kompleks Science-Technology Center at the Thermal Engineering Institute on the basis of the SS-20 and SS-25 military rockets are capable of launching from any point a satellite weighing 0.7-0.8 ton into an orbit with the necessary inclination. Viktor Andryushin, deputy director of the science-technology center, feels that the Start will find its niche in the market.

The Design Bureau imeni V. P. Makeyev (at Miass), the state rocket center, has planned to transform the military ballistic missiles falling under strategic arms control into commercial rockets, but in the opinion of Rem Kanin, laboratory head at the Makeyev Design Bureau, it will not be possible to begin commercial launches sooner than after 2-3 years.

Even among the leaders of the branch the future prospects are not entirely clear. Private and joint-stock company capital will not soon become a client of space launches and the world market long ago was divided up between the European consortium Ariane Space and the American companies Martin Marietta, General Dynamics and McDonnell Douglas. Russia, whose potential capabilities for commercial launches are about 60% of the total capabilities of the space club, holds but a tiny portion of the market—only 3%. Three times less than China. However, this is a natural result of the many years of orientation of the USSR on "prestige" manned flights—the race for duration records had no commercial payoff.

Now the demand for space services is 2 or 3 times greater than what is available and the list for launches is signed up for years in advance. Despite this, the United States does not intend to waive its third of the profits from commercial launches and feels that Ariane Space should "move a little" and yield a part of the market to Russia. It goes without saying that the European countries, joining together in a consortium, are adhering to the opposite point of view. It is obvious that in this situation

the more or less successful entry of the Russian Federation into the space market will be dependent not so much on the commercial activity of our companies as on the political will and decisiveness of the Russian government.

The second direction in commercial space is communication and television. More than 15 nongovernmental organizations are active in these fields. Many of their projects are included in the federal space program. The need for further development of this part of the space market is indisputable but investors are in no hurry to invest their money in the projects, despite their evident advantage. The investment cycle in the space industry is very long: even if much work has already been done, the time required for recouping costs drags out over several years. As a result, a number of satellites intended for Russia have already gone abroad; the developers, in need of money, are leasing them out or are handing them over completely to foreign clients.

Finally, the third direction, now developing most intensively, is the sale of the technologies, know-how, materials and equipment already developed in the USSR. There are more than a few contracts and they are giving rise to mixed feelings. On the one hand, it tickles the vanity that the foreign aerospace industry willingly is purchasing things developed long-long ago. It almost seemed that we already were among the outsiders and nevertheless as before we are ahead of the entire world.

For example, the American corporation Aerojet Propulsion Division acquired from the Samara NPO Trud the NK-33 oxygen-hydrogen engine already developed in the late 1950's. The Soviet N-1 booster, intended for flights to the moon, was outfitted with this engine.

The NPO warehouses still store more than 70 engines which have undergone firing tests and have been mothballed. Aerojet intends to use them for its Talas and Delta rockets. And this is not surprising at all because the NK-33 embodies unique engineering ideas and solutions, many of which even now are not outdated.

Rockwell International is purchasing five androgynous docking units from the NPO Energiya for 18 million dollars. Their "forefather," developed under the direction of Vladimir Syromyatnikov, already in 1975 ensured the docking of the Soyuz and Apollo, pathetically called "a handshake in orbit." Now the modernized unit will make it possible to dock the Atlantis ship to the Mir station. The Shuttle flight is planned for 1995. It goes without saying that the three-month expedition of an American astronaut on the Mir has no commercial significance—this is a purely political action. Moreover, the foreign exchange which the NPO Energiya will receive will be spent on the continuation of manned flights, whose desirability is more than questionable. But this is not the most important question—it is noteworthy that the Americans will take over a unit developed twenty years ago. But all the same we whimper: Russia is a backward, primitive country, as if it is being pulled up to the level of the technologically developed countries. And in its fullness...

Are we really coming out ahead?

Other examples from this field no longer arouse patriotic feelings. More likely they give rise to a vexingly unpleasant question: are they trading with us or trading us? The McDonnell Douglas corporation has concluded an agreement with the Progress plant at Samara for acquiring materials and units for their production. However, the output of boosters for ourselves at the Progress plant has been virtually completely terminated. The NPO Kompozit has already signed 28 contracts with the Chinese People's Republic for the delivery of welding materials, technologies and equipment. However, the total sum is more than modest: 1.6 million dollars.

In general, more than a few well-known companies—the Central Scientific Research Institute for Machine Building, the Scientific Research Institute for Thermal Processes, the Samara Central Special Design Bureau, the Russian Scientific Research Institute for Space Instrument Making, the Radio Communications Institute and the scientific production associations Energiya, Energomash and Tekhnomash are participating in trade with China. Monetarily this vigorous commercial activity is estimated at only 10-15 million dollars, which moreover is not easy to obtain because China is striving to pay for more than half the value of the contracts by barter. Why would space companies want to exchange their products for consumer goods, which it is virtually impossible to get rid of on the internal market, for those very same items which would be available even without participation of the mighty Russian cosmonautics branch?

The conclusion is obvious: the policy of squeezing Russian companies out of the world market is forcing them to sell off what was accumulated during those years when our country was regarded as the leading space power. Wholesale and retail, in large part at reduced prices, and what hurts the most—to our own competitors.

Assessment of Current State of Cosmonautics

957Q0001A Moscow VOZDUSHNYY TRANSPORT in Russia No 38-39, Sep 94 pp 1, 3

[Article by Leonid Golovanov, key scientific specialist, Russian Academy of State Service under the President of the Russian Federation, member of the Presidium, Academy of Cosmonautics imeni K. E. Tsiolkovskiy: "Cosmonautics in the Agenda for the 21st Century"; the first paragraph is an introduction]

[FBIS Translated Text] As we already have reported, the Tenth International Congress of the Association of Spaceflight Participants and the International Aerospace Congress, dedicated to the 60th anniversary of the birth of Yuriy Gagarin, were held in Moscow in August 1994.

The capital cheerfully received the guests—research scientists, specialists engaged in the development of highly complex technical systems, directors of planning-design and production groups and cosmonauts—all converging here from the entire world in order not only to pay their respects to the country which was the trailblazer in extraterrestrial space, but also due to the need for broadening and strengthening creative relationships, the need for generalizing accumulated experience and for exchanging opinions on the future of the continuing march of all mankind, the "planet of people," into space. Today we are publishing the thoughts of one of the congress participants...

In the program for actions given the name "Agenda for the 21st Century," which was adopted in Rio de Janeiro in June 1992, there is no special section devoted to cosmonautics. Although, it goes without saying, its participation in the solution of global problems of the planet, especially ecologic, is assumed and to be sure was not left without a certain attention in the discussions and in the adopted documents. But, we note, under the tradition which has developed, in cosmonautics they see only the totality of the scientific and technical means favoring the solution of the mentioned problems, and if it can be expressed so, something exotic in the form of space flights and a politically prestigious "luxury" against a background of troublesome terrestrial concerns.

We recall how in the 1960's there was even polemics among scientists: why are we concerned with space when there is still so much to do on Earth? Echoes of this, but no longer only at the theoretical, but also at the level of the everyday consciousness, in our day have sounded from the mouths of some political figures as populist doubts. Thank heaven that they have not found response in society. But meanwhile it should be evident that from a relatively narrow and specialized direction in the scientific and technical revolution cosmonautics has grown into a powerful and ever-broadening main line of scientific-technical, economic and cultural progress as a whole. Moreover, and I do not fear to say this, it constitutes the initiation of a new quality of civilization, a transition of the world community to a new, higher stage of its natural historical development.

The expression "space era" became a catch phrase but then it was quite worn out by its repeated use in the enthusiastic means of mass information and in everyday use no longer produces its earlier impact, but, we agree, it very precisely expresses the sense of the great reality. And by virtue of the very essence of cosmonautics it is being transformed more and more into a sphere of activity for all mankind, breaking down national boundaries and drawing peoples and states to integration in joint efforts to ensure the planet stable development along the lines of higher ideals.

What, you may ask, is the basis for this assertion? I respond: cosmonautics not only in a concentrated way incorporates the most noteworthy attainments of the scientific intellect and work productivity, but it also directly brings into existence a qualitatively new technological base of society, involving both new tools and new subjects and objects of expedient cognitive and practical transforming activity and new forms of organization of this activity, as well as new ways for joining man with means for its implementation.

In the last analysis it also requires a new man, be it for strictly terrestrial or space work in the organic unity of a multifunctional branch.

It will be no exaggeration if we say that the implementation of cosmonautics opened a new facet of the human essence and at the same time meant a changeover of mankind to a new form and way of life in response to the objective needs of society for the mastery of a new sphere of its vital functioning.

This, in his genius, was foreseen by Konstantin Eduardovich Tsiolkovskiy—the apostle of mankind's space consciousness. He not only theoretically validated the possibility of flights into space and proposed the technical means for implementing them, but also was the first who visualized programmed, including sociohumanistic, apparatus for "space" construction in the interests of multiplying the creative powers of mankind, for the settlement of space.

Cosmonautics was established in a surprisingly short historical period. Now it is serving as a solution for world and regional scientific and socioeconomic problems, fundamental studies of the Earth and universe. Due to the unique capabilities of space vehicles a planetary scanning of the geographic envelope of the planet became a reality. Continuous hydro- and meteorological observations and monitoring of the environment began from circumterrestrial orbits. Space telephonic and telegraphic communication and radio and television broadcasting between cities, countries and continents was initiated. Marine navigation and geodetic referencing of terrestrial features, on-line notification of ship and plane accidents and exceptional situations at all latitudes and meridians are being ensured... And so forth.

We will cite only one example. The role of the stock exchange as a regulator of a market economy is generally known. And suddenly there is a global stock exchange whose functioning is intensifying the productivity of labor in the world economy by 22-23%. This became possible due to space communication and a geostationary satellite is constantly hovering over New York; take it away and commercial relations at a planetary scale would immediately be disorganized.

In addition to a high, "elite" technology, ensuring the production of the most modern space systems and vehicles, a strictly space technology also developed—its purpose: experimental, trial and semi-industrial (in the not distant future—also completely industrial) production of very new materials in space, also including on a

commercial basis. For example, under the "Foton" program the fabrication of technically necessary single crystals, biologically active substances and protein crystals with characteristics unattainable under terrestrial conditions is being perfected under microgravitation conditions. The saving is estimated at millions of dollars.

Today the results of space activity are being used in more than 130 countries throughout the world. Among these 17 are implementing their own space programs. The international space market is developing at a rapid rate. Its annual income in the year 2000 may attain several tens of billions of dollars. According to the calculations of a well-known economist at the Moscow State Technical University imeni N. E. Bauman, the total world services for the purposeful launch of space vehicles into circumterrestrial orbits in monetary terms will attain 110 billion dollars by the beginning of the 21st century.

In 1960, when our cosmonautics shook the entire world with its first- time attainments, the American president John Kennedy declared: "If the Russians control space they will be able to control the Earth." And the race for space leadership began to develop. Unfortunately, it resulted in the militarization of cosmonautics. The practical expression of this was demonstrated for the first time during military operations in the Persian Gulf zone in 1991.

It would be naive to expect that with cessation of the "cold war" among the superpowers this problem, alarming for the entire world community, would automatically disappear, but I would like to emphasize that a deep-seated tendency in the development of cosmonautics in our country from the very beginning was the pursuit of strictly peaceful objectives.

Even more bewilderment is generated by the fact that the entire rocket-space branch fell under the hot hand of "wild" conversion, which had not been thought through. A groundless shutdown of research, planning and production of the latest transportation systems, space stations, assemblies and apparatus began. Cosmonautics was the hostage of a superficial policy. Then a dough maker, based on outdated models, and home kitchen equipment based on Japanese licenses, appeared on the stands at the NPO Energiya and at the Khrunichev plant—"Druzhba" bicycles for children... That's a subject for another discussion; we note only one thing: the branch of many thousands of workers was demoralized and unique talented groups which had been built up over the decades began to downsize, and in some places, also began to fall apart. That which had constituted our national pride and great achievement was squeezed out in favor of momentary, in many cases random goals, dictated by the conditions of an economy undergoing ruination.

If one takes a broader look, the "cold war" passed from the military-political arena into the economic sphere and matters of national security, to which cosmonautics continues to have the most immediate relationship, acquired an intraeconomy character. Attempts to go from high-class production to the international civilian and military market in order somehow to ensure survival of our own intellectual and productive potential ran into hard competition and irresponsible hopes for foreign investments put cosmonautics under the threat of subordination to the programs of others.

Meanwhile the importance of cosmonautics for the further development of mankind in general is increasing and even in the West many understand our role in this, in an alarmed state seeing how we are slipping from leading positions to secondary roles. It goes without saying that foreign financial and industrial wizards are now wringing their hands in satisfaction and little-by-little are beginning to propose their conditions. But these are the conditions of private interests, not the objective imperative of civilization.

It is sad and alarming that national cosmonautics on the eve of the 21st century has found itself in a pathological state. The impact of its situation extends beyond the boundaries of the branch itself; it is a manifestation of the sickness of our social organism as a whole and recovery is possible only on the basis of fundamental approaches to the entire economy. Palliative solutions are ill suited here. The survival of individual scientific-production associations under calamitous market conditions will not determine the fate of the branch as a whole. And in it, in this branch, there is embodied not only our historical pride, but also our great hopes for the future, including a guarantee of the political authority of Russia on the world map.

Interview With NPO PM Director Reshetnev

957Q0002A Moscow VOZDUSHNYY TRANSPORT in Russian No 40, Sep 94 p 6

[Interview between Vladimir Khokhlov, journalist, and M. F. Reshetnev, general designer and general director, NPO PM (Applied Mechanics Scientific Production Association); the first two paragraphs are an introduction]

[FBIS Translated Text] August of this year marked the 30th anniversary of the day of launch of the first booster constructed at the NPO PM from Krasnoyarsk-26.

Journalist Vladimir Khokhlov interviews Academician M. F. Reshetnev, NPO general designer and general director.

Khokhlov: Mikhail Fedorovich, the NPO PM is known as an enterprise which constructs satellites. But in fact its first independent creation was the IIK65M booster. How was this booster created and what was its subsequent fate?

Reshetnev: From the first days of formation of the enterprise we were generally speaking concerned with military rocket technology. Attempts were made to develop further the idea of a rocket to be used with a

mobile launcher. The fact is that while working with Korolev at Pidlipki I at one time was the chief designer of the VKII mobile complex, which was put on line in 1957.

The complex consisted of the R11M tactical rocket (with a nuclear warhead), which charged with fuel components was transported on a fixed launcher constructed on the basis of a self-propelled artillery piece from which the gun had been removed and which was supplied with armor.

Later, after a number of modifications of the rocket itself and transfer to a wheeled vehicle, this complex was designated the SKAD.

This was an R11M missile with a nuclear warhead. It was later modernized and its effective range was increased. Subsequently the complex was transferred to a wheeled cross-country vehicle and later this was the SCUD, well known due to the war in the Persian Gulf.

Under these conditions Mikhail Kuzmich Yangel, who headed the design bureau at Dnepropetrovsk, and we had very good relations with him, proposed that we take over space work from his design bureau. Yangel in actuality wanted to concentrate the efforts of his design bureau on military rocket technology, strategic combat missiles. We concluded an agreement and took on the very initial stage in development of a booster which was then named the 65S3. It was used as the first stage of the R14 intermediate-range missile. It was necessary to make a second stage in order to ensure attaining first cosmic velocity. We solved this problem together with the design bureau of Aleksey Mikhaylovich Isayev, which developed a special repeatedly firing engine. At that time no such engine yet existed; this was a bold concept and it was possible to realize it successfully.

In addition, we began work on small communication satellites because by making the rocket and satellite in a single design bureau it was easier to bring together the entire range of problems and the solution of the problems arising in the course of this work depended on us.

During subsequent years eleven rocket-space complexes were developed using our booster, which was designated the 11K65M; these were complexes developed in the interests of both the Ministry of Defense and the economy and two complexes developed in the interests of the Academy of Sciences. This booster is still in use and is the principal carrier for putting small and medium earth satellites into circular orbits at altitudes up to 1500 km.

Khokhlov: The enterprise received experience in missile development, but rocket production did not become the main specialization of the enterprise. Was it not tough to lay aside the planned development work and shift to a new field—communication satellites?

Reshetnev: It is not very interesting to make a satellite or rocket separately; a rocket-space complex was important. The developers of satellites are seeking a suitable booster, are joining hands, are combining efforts, whereas for us everything was under one roof.

Rocket technology has not become the principal work of our enterprise because all the "niches" in the field were occupied and for us, a young enterprise, it was already impossible to "fit in" anyplace. Accordingly, while making the 11K65M rocket we began to construct satellites for different purposes which this booster could launch.

Why did we take up specifically communication satellites? Mikhail Kuzmich Yangel simultaneously with the 65S3 wanted to turn over to us several satellites, also in the initial development stage. There were three satellites—two communication satellites and a satellite of the Meteor type. We took the communication satellites, but we did not risk taking the Meteor, which at that time was very complex for us. We began to develop these two communication satellites for the Ministry of Defense and for all practical purposes by 1964, when the booster flew, we already had done a good amount of work on these satellites. It is true that our first booster flew with three payload mock-ups of a satellite, but on subsequent launches regularly operating communication satellites were already launched.

In these same years we began to work on navigation and geodetic satellites. We understood that it was precisely in these fields of cosmonautics that it was possible to give that which was most of all needed by society and which could solve the most timely problems. Over the course of 30 years we developed 16 types of communication satellites alone—both in the interests of defense and in the interests of the economy.

Khokhlov: So it appears that on the average there has been a new communication system each two years?

Reshetnev: One might think that this is a great many, but as of today we have the following figures: the area of the United States is serviced by about 800 repeaters, whereas as of now the number of repeaters operating for Russia is considerably fewer.

Khokhlov: The NPO PM up to the present moment, that is, as of today, is a monopolist in the development of many types of satellites. What pluses and minuses are there in this situation and is this now helping or hindering the situation, considering the sharp decline in income received from state orders?

Reshetnev: About the monopoly. First—about the minuses. A monopoly is when all users go to one producer. And we, in actuality, until recently in those directions in space technology about which I have spoken, were monopolists. To what does this usually lead? The result is that there is no real proper struggle to reach a higher technical level, to shorten deadlines, because no one is barking at your heels. A monopolistic enterprise sometimes even dictates to users what they can receive. I feel that this is a minus.

True. I must say that the workers of the NPO PM have never abused their monopolistic position and strove to make things better and do the work more rapidly. There are also definite pluses in this—a calmer life, relative material well-being in production work, etc. Is this helping the situation today? Orders have fallen off, but even today we are monopolists and this, of course, is helping us. But this will not continue for a long time. Under the present conditions of conversion and reduction of state orders everyone who has any capability for doing so has rushed to take up the production of communication satellites. They are no more stupid than us, they have pretty good cadres of workers, and after some time passes they will turn out satellites suitable for operation. But what is to our advantage is that for the time being they are yet to learn how to solve these problems, whereas we have 30 years of experience, we have experienced highly qualified personnel and a corresponding experimental base, and under these conditions it is necessary for workers to work better and more rapidly. Now, to be sure, with the economic state of the country, failure to receive payment for work done constitutes a very great hindrance, but we are striving to pursue such a line.

Khokhlov: The NPO PM already for several years has been seeking propitious contacts with foreign companies both for construction of a satellite and for work with individual systems and technologies. Have the results been effective? What are the prospects for constructing a joint European satellite?

Reshetnev: We already long ago made such contacts and are working with foreign companies. We have drawn up a preliminary design of a satellite with Canada. We have established the Sovcanstar Satellite Communication Corporation, made up of several Canadian companies and the NPO PM.

Khokhlov: What is the present status of the project for the SOVCANSTAR satellite?

Reshetnev: We still have not signed a contract. Financing aspects at present are being hammered out.

With respect to construction of a joint European satellite. We have the SESAT project—a communication satellite. We are working on this project with the French company Alcatel. Right here I have a letter from Jacques Grinier, general director of the European Communication Satellites Agency, with a request that their delegation be received early in September for continuing negotiations on this matter.

Khokhlov: And you of course are carrying out work on individual systems and technologies?

Reshetnev: Such work is being done, but it is small in scope.

Khokhlov: Do you feel that such work is productive when specialists are cooperating in some foreign projects?

Reshetnev: Such work is very productive; on the one hand it is increasing the technical level of our specialists and is affording them the possibility for broadening their outlook, and on the other hand it is bringing at least a small income to the NPO PM.

But these two mentioned satellite projects are more capital-consuming, larger measures.

Khokhlov: Workers at the NPO PM are working today almost from pure enthusiasm; the payment for their work does not cover the cost of living. It cannot go on that way for long. What improvements in the situation do you see in the immediate future?

Reshetnev: The situation is not easy, but is not deplorable. As of today the average salary at the enterprise is about 350,000 rubles. For those who are today working. The enterprise operated 4 days a week, then 3 days a week. Since the middle of June we have laid off 3500 persons, but they are being partially paid, the average pay being about 120 thousand rubles a month. For those who have remained the pay has been increased by a factor of 2 1/2, which on the average is about 350,000 rubles.

With respect to change in structure of the enterprise. We collected proposals from the subdivisions and our individual workers. These proposals were analyzed at an administrative council which was specially established for solving these problems. We received the results of the discussion and the changes will soon be made. It is possible that we also will have to make some cutbacks due to the fact that in the state budget for the Ministry of Defense only half the funds have been allocated that had been announced and therefore definite funding difficulties remain.

Khokhlov: As you stated, the NPO PM never abused its monopolistic position and there were virtually no parallel structures. How can a downsizing take place?

Reshetnev: These resources can be arranged differently, used differently and concentrated differently in the necessary directions. A requirement for survival is to change and improve the existing structure.

We have not wrapped up our space work. But conditions in the country require definite maneuvers on our part and we cannot but make them.

Khokhlov: The other day a communication suddenly appeared about the transfer of a number of enterprises, including the NPO PM, to the Russian Space Agency system. How may this be reflected in the position of the enterprise?

Reshetnev: The fact is that during the last two years we were in the Russian Defense Industry system. But the Russian Defense Industry system is an enormous monster organized from the eight former defense ministries, an unmanageable structure. It is made up of more than 1500 enterprises. Accordingly, the rocket-space field was

"submerged" in it. The leadership of the Defense Industry system, since there are completely different specialists there, was unqualified to manage our branch. And we felt that. During two years there was not a single board meeting nor one attempt to look into and to analyze our problems. The leadership of the Russian Space Agency, especially Yuriy Nikolayevich Koptev, its general director, correctly raised the point that under conditions of cutbacks in the army and disarmament it would certainly be impossible to save these 1500 enterprises. Some of these "will sink" and others will become enterprises supported at public expense. Accordingly, Koptev at the governmental level demonstrated that it was necessary to designate "an elite group" of enterprises, to ensure them state support in order that Russian space technology not finally perish. I, as a general director, supported this position at all levels.

During the last year we repeatedly addressed appeals to the government of Russia and we succeeded in seeing to it that our appeal to the president in fact reached the government. We demonstrated with reason after reason that it was necessary to incorporate a number of enterprises in the Russian Space Agency. The president gave appropriate instructions. On 25 July the prime minister V. S. Chernomyrdin signed a decree transferring 38 enterprises to the RSA, including the NPO PM. This matter was first examined by a commission of the Safety Council on 20 July. I spoke there and demonstrated the need for this measure. What will this provide us? Whether we survive—we will see, but in any case the idea of designating a number of enterprises, granting them tax relief and solving other vitally important problems will yield its fruits. This does not mean that on 25 July they transferred us and an easy life is beginning at once. A certain time is needed, as they say in such cases, before light will appear at the end of the tunnel because I regarded our presence in the Russian Defense Industry system as absolutely without prospects. Now such prospects have appeared.

Current Organization of Civil, Military Space Activities Criticized

957Q0004 Moscow SEGODNYA in Russian 5 Oct 94 p 9

[Article by Mikhail Chernyshov, under the rubric "Intentions": "The Military-Space Forces Want a Celebration Day"]

[FBIS Translated Text] The exploration of space by our country, and in fact by the world, takes its history from 4 October 1957, when the first artificial earth satellite was launched. Specialists of the military units that supported the launches of the first satellites mark that day as the holiday celebrating their profession. The financial group MOST gave out more than 40 million rubles [R] for the festivities that took place yesterday in the Central Office of the Russian Army. But the workers of the space sector wanted a response from the state structures that would be proper to the event. It still hasn't come.

The space program in the USSR, as everyone well knows, was "exclusively peaceful." Accordingly, the first satellites and, later, the spacecraft, the orbital stations, and all other such equipment systems could, on an a priori basis, be only of a science-related or national-economy-related nature.

If two areas of space activity were absolutely clearly demarcated in the United States—civilian and military, NASA and the Air Force—all the expense items were mixed together to the extreme in the USSR. The Americans had orbital vehicles that were purely for science, and they had a multitude of military vehicles—reconnaissance satellites, several dozen types, for early warning against nuclear attack, and asat weapons. All of ours were hidden behind the faceless, phenomenally large series of Kosmos satellites, a series that was launched "to continue research in outer space." That didn't fool anybody. Specialized foreign publications gloatingly recorded the "peaceful Kosmoses, rendering each its due. Sometimes they were wrong. The space generals were happy about that: our potential opponent doesn't know everything, and that's why he "misses" sometimes, which means that our overall technique of leading him astray is good. But we weren't so much leading our opponent far astray as we were leading ourselves astray.

The exclusively peaceful Baykonur—according to Lt. Gen. (ret.) Viktor Favorskiy, the former chief of the main directorate of space systems of the USSR Ministry of Defense—was financed by the missile forces. They provided for its maintenance and trained the personnel for it. The military were not only involved in the launches of the space vehicles—they also performed flight control. Space, according to Favorskiy's definition, can be broken down into four main areas: national security support, national economy needs, science, and projects involving international cooperation. All four branches are intertwined with one another. Not a single country in the world is creating separate infrastructures for each type of operation involving space vehicles. The USSR, in the opinion of the military people, had found the optimal form for servicing all space systems. Crews for individual tracking stations are often located in hard-to-get-to places and work round-the-clock. It's hard to attract civilian specialists to such work, but for the military, such extreme conditions are customary. When the state budget was, in fact, unified, all the responsibility for launching and servicing space systems was assigned to the Ministry of Defense. The other departments took advantage of the various space benefits free of charge, as it were: communications, weather forecasts, geological and fishing survey results, navigational information.

It was only later that—according to Maj.-Gen. (ret.) Nikolay Dmitriyev, now the general director of the Kosmos Scientific Research Center—communication satellites were divided into military and civilian, after, for example, the satellites couldn't handle new, larger

volumes of information being relayed. But for a long time, the money continued to be doled out for such systems out of the budget line. It was first distributed to the military departments, then to the Ministry of General Machine Building (MOM), which was civilian in form, but defense (read: military) in content.

But that kind of camouflage offends even the military specialists. They feel that, under such changes, the priorities in financing have gone over to the civilian programs, whereas for the military projects (for the domestic taxpayer and the world community, it's still as if they never existed) the money is now being doled out on the basis of the what's-left-over principle. The what's-left-over principle is strange when you consider the fact that the main job of MOM was regarded to be the creation of nuclear-missile weaponry. After allotting money for job No. 1, a certain departmental commission would give the remainder to "space," and it was at that very stage, the military assert, that they were most offended.

The current stage is characterized by an even greater degree of uncertainty. The attempts to arrange everything as the Americans have it—setting up a Russian Space Agency [RKA], making the Military Space Forces into a special branch of forces—has done little so far. Moreover, some special financial/legal cases are appearing in which barely any reasonable explanation is being given when, say, the civilian RKA—which, to put it lightly, is certainly not suffering from an excess of funds—announces its readiness to maintain some of the Russian military personnel who service Baykonur. We could talk, of course, about how the circumstances are extreme. But that's not the point. People who have been at the cosmodromes, in the control centers, and in other space-related facilities know how truly great is the contribution made by the specialists in uniform to the operation of the complex systems. Of course, it makes no sense at all to be counting how many of them were rocket specialists and how many were artillery specialists, or flyers, or seamen.

By presidential decision two years ago, they were all combined into one unit—the Military Space Forces. There's no sense, either, in trying to calculate whose contribution to the creation of the first satellites was more significant—that of the civilian specialists, or that of the military specialists. Yes, many rockets and space vehicles were manufactured at places other than plants of the Ministry of Defense. But the first satellite-control center, and the only one back then, was outfitted in Moscow, in the Arbat district, in the basement of the old General Headquarters. Later, it was moved to the military barracks next to the Frunze subway station; and only years later did we have the "civilian" flight control centers, which everyone got to know from the many newspaper and journal photographs. To this day, the famous Zvezdnyy and other facilities have, along with their "open" names, numbered military designations.

Development of Reusable Air-Launched Booster Systems Urged

957Q0005 Moscow SEGODNYA in Russian 6 Oct 94 p 9

[Article by Mikhail Chernyshev, under the rubric "Thoughts": "Buran, Black Jack, or Something Totally New? Whatever the Stake, the Aircraft Designers Intend To Get Revenge From the Rocket Designers"]

[FBIS Translated Text] For more than a half a century, since perhaps the time of the "star dreamer" Fridrikh Tsander, an argument has been going between rocket designers and aircraft designers about which is the more economical way to explore space—with expendable rockets, or with reusable spaceplanes? The rocket designers have won so far. They are carrying most of the burden in the exploration of near-Earth space and the study of the planets. The American Shuttles, the Soviet Buran, and the yet-to-be-completed Western European Hermes—reusable systems that appeared on the scene after the rockets—represent a whimsical combination of rocket and airplane.

In terms of economy, the reusable systems have not lived up to the hopes that people had for them. At one time, the creators of the American "shuttle craft" promised to reduce the cost of delivering a kilogram of payload to orbit to just about $200. Nothing of the sort has happened. Even with the most economical expendable rockets, the "going rate" is several thousand dollars per kilogram, and with the American "shuttle craft," the rates are considerably higher. Don't even mention Buran: huge amounts of money were spent on the development and construction of several craft, and those neglected "vessels" are sitting out in the far reaches of the steppes of Kazakhstan. And the spaceplane made a total of just one experiment flight, in pilotless mode. There probably won't be any other flights. It looks as if the Western European Hermes won't ever see the sky at all.

It took a whole 30 years to develop expendable boosters capable of lifting anything into space, says German Zagaynov, the director of TsAGI [Central Aerohydrodynamic Institute]. Another three decades were devoted to the creation of the gamut of rockets that cover the entire range of payloads that exist today: payloads that go from several hundred kilograms to hundreds of tons or more. Those boosters, based on today's concepts, are almost ideal in terms of design; series production has been perfected; and there's an infrastructure in place to service the launches. Competing with them in terms of economy is an almost hopeless affair. But specialists now are counting on systems with a so-called horizontal launch: when a spaceplane goes up into orbit by using a larger, carrier aircraft as a launch platform. In the opinion of designers from the United States, Russia, and other countries, such a plane can still find a niche and will perform operations in which it would be inefficient to use expendable boosters.

The response to such intentions has been varied. When the HOTOL project was announced in Britain in 1987, it got no support from the European Space Agency or the government itself. Only Rolls Royce saw fit to take a risk. The seeds of the call, nevertheless, were planted, and the romantics of aerospace found followers. Within two years, German specialists introduced the world community to the Saenger project. Today, similar projects exist in other countries, too. States such as Japan, China, and India, for example, are displaying a great deal of interest in spaceplanes.

The launch of a spaceplane into orbit from a carrier aircraft has a number of advantages over a rocket. The "launch pad" is not tied to any particular place, which means that many of the political restrictions often associated with space launches are removed and there's no need to set aside land for right of way, that is, expansive tracts of land along the flight trajectory of the booster on which spent rocket stages fall.

Everyone knows of the project that involves the use of the Mriya aircraft as a flying cosmodrome and that links three participants in cooperation—Ukraine, Russia, and Britain. There's less information available on the possibility of using the Tu-160 supersonic strategic bomber (called Black Jack by NATO) in a similar role. That airplane was originally created in response to a similar American aircraft, the B-1B, a cruise-missile platform. The dazzling white Black Jack has four engines and a wing geometry that is variable in flight. It flies at a speed that is a little more than twice the speed of sound. People regard it as the biggest military airplane every created.

While there is still only one Mriya aircraft to this day—Ukrainian aircraft builders will never finish the second—there are plenty of the Tu-160 bombers around. Using them as a flying cosmodrome or, if you will, the first stage of a booster requires only a minimal amount of reoutfitting of the airplane—essentially just removing the weapons and ammunition. The second stage would be an already separate reusable spaceplane. But even that two-stage profile could be of only temporary interest to the space program.

The future—in the opinion of Prof. Aleksandr Pukhov, one of the leading specialists at the Tupolev firm—is with systems such as the Tu-2000 single-stage-to-orbit aerospace plane. The takeoff weight of the craft is 70-90 tons, and its length is 60 meters. The spacecraft burns liquid hydrogen. There is a two-man crew. If the people on the ground want to set up normal freight traffic into space that is moderate in terms of cost and to handle applied, science-related, and (God help us, all it takes is one wise guy to start it, and the rest jump in—**Ed.**) military objectives, then they need to rely on that very "space horse."

In the past, when the issue of choosing the most efficient space transportation systems was being handled, an interdepartmental scientific-technical council was formed in the former USSR. Its decisions recorded unambiguously that the high road to space is a single-stage-to-orbit reusable aerospace plane. But any technical problem is solved with the means that are accessible at that stage of technological development. In the fifties, Sergey Korolev was able to launch a satellite with only a three-stage rocket. Today, we have, for example, the Mriya, which in essence can be the first recoverable booster stage; but then, as has already been said, there's the Black Jack, which is better in terms of the preliminary altitude of lift and the payload boost velocity. And then finally there's the ideal, as it were, single-stage-to-orbit Tu-2000.

We need to achieve not simply a 15-20 percent reduction in transportation expenses, says Prof. Pukhov, but changes that are more radical. And that can be done. Here's just one example. Right now, the American shuttle craft use an expendable fuel tank. It's a multilayer thermos that can withstand incredible temperature differentials. One square meter of the shell weighs 30 kilograms. The weight of the tank needs to be reduced twofold, and the tank has to be made so that it can be used, say, a hundred times. It's a difficult task, but doable. Only by doing those kinds of things can real economy be achieved. In the ideal, "reusable" means that the system has no expendable parts at all. Individual components such as, say, the chassis, could be replaced after 5-10 flights, but the airplane as a whole must be capable of making 100-150 flights into space. Servicing it requires fewer personnel than does servicing rockets, and the need for erecting facilities such as assembly buildings and launch sites is eliminated.

Single-stage-to-orbit airplanes would best be used for placing small and medium-sized cargoes—6-10 tons—into relatively low orbits—400 km or under. Until recently, the greatest demand was for placing large communications satellites into geostationary orbit. But all of a sudden, there's also a need for small vehicles that circle at low altitudes. Hundreds of them are needed.

Mikhail Kazakov, lead designer at the Tupolev ANTK [not further expanded], feels that there are technical inventories that would make it possible to flesh out various kinds of boosters, but things depend less on technical possibilities than on money. We are talking about outlays of $2-3 billion. Of course, it would be better to do such a project in cooperation with, say, Germany, which, as has already been said, has the Saenger project, which is similar to ours. But each state has its own way of handling such problems. The United States, for example, doesn't want to share anything with anybody. It wants to have its own equipment exclusively and then sell it. But then, that's their right. But we, it seems, still should seek out partners. But mainly, with today's meager state financing, we should do at least the minimum experimental work on future spaceplanes, so that we won't be left standing by the side of the road.

Living Conditions in City of Mirnyy at Plesetsk Cosmodrome

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[Article by Anatoliy Stepovoy and Viktor Filippov, IZVESTIYA correspondents: "A Terrestrial Glance at Space Plesetsk. Children, Potatoes and 'Poplars' Grow in Mirnyy City, Which Does Not Appear on Any Map"; the first two paragraphs are an introduction]

[FBIS Translated Text] Lt Gen Yuriy Zhuravlev, chief of the garrison at Mirnyy City, has forbidden that his soldiers leave their military units until the bears in the neighboring taiga are hibernating in their dens. There are now few mushrooms and berries to be had and the clumsy animals fiercely rummage around the military settlements in search for anything they can find to eat.

Mirnyy City in Arkhangelsk Oblast, even if it is not marked on readily accessible maps, is known even less than its Yakutian namesake, where diamonds are produced. In fact it is known only under its pseudonym: "Plesetsk cosmodrome."

In 1957, in the swampy taiga between Arkhangelsk and Kargopol, military builders established a base for intercontinental ballistic missiles. And after two years at this base there was a trial launch of a powerful "object," marking the birth of the strategic arms forces in the USSR. Nikita Khrushchev, pounding his shoe on the UN podium and threatening the capitalists that they would be buried, had in mind the Vostok missiles with a nuclear warhead which stood at combat readiness in the Arkhangelsk taiga.

The military-space forces were established in Russia two years ago. Their principal center is located here, in Mirnyy City, at the base of the state test site of the Russian Federation Ministry of Defense. But the pseudonym "Plesetsk cosmodrome" appeared long before the military-space forces were established. On 20 June 1983 the newspaper PRAVDA, at that time the principal newspaper in the country, was allowed to print a report on the launch of a satellite of the Intercosmos series, concealing the test site under the name of Plesetsk village, which is situated four kilometers from Mirnyy. This is a strictly civilian settlement whose inhabitants saw timber into boards and grow broilers and they see missiles only on the TV.

"In actuality for almost 30 years we have been performing the function of a cosmodrome," says Major General Anatoliy Ovchinnikov, the chief of the principal center of space facilities, who is 44 years old. "But juridically no cosmodrome exists in Russia. This is a test site which is funded by the Ministry of Defense."

The test site occupies about 2000 square kilometers of taiga. All the trees have been removed from this territory. Their places have been occupied by so-called "sites"—military settlements where missiles are tested and from whence they are launched into space. Entry into Mirnyy, and especially to a "site," is possible only by special passes, passing through numerous check points.

Journalists usually arrive at the test site in order to look into the sky. But we decided to look around on the ground: how do the test site inhabitants live during their time off the job?

Two highways lead to Mirnyy—one from the direction of Arkhangelsk and the other from Kargopol. Both are partially paved with asphalt. You drive along such roads both during the autumn season of very bad road conditions and during the ordinary times of still rough road conditions... And the classics are so right in warning that in life there is always room for heroic feats.

On the other hand the highways within the test site are excellent. The officers call them the gift of Yeltsin. It is rumored that during a visit to Mirnyy Boris Nikolayevich wished to see a missile launch. They took him to one of the sites. But the test site roads had last been patched at the time when Khrushchev threatened the world with his shoe. And the armored limousine of the president of Russia jerked along the ruts like it was about to take off. At the site Boris Nikolayevich stated that he was struck by the unique missiles and the rotten roads. And a month later, by order of the president of Russia, the test site was allocated a major sum for road repair.

Mirnyy City stands on the banks of the shallow Lake Plestsy, overgrown with waterlilies. A block of two-story wooden buildings has remained here from the first builders. All the rest are buildings from the Khrushchev era and several nine-story high-rises. There are about 40,000 inhabitants, mostly the families of military personnel. The absolute majority of the adult inhabitants of Mirnyy have a higher education.

"Mirnyy was established in order to ensure the vital functioning of the state test site," says Yuriy Tyurikov, a pediatrician, 40 years old, deputy head of the city administration. "Therefore we are funded from the federal budget, bypassing the oblast budget. The hospital, four schools, children's hospital, children's art school, children's sports school and two residences are managed by the civilian authorities. Everything else is the property of the military. In the city there are 300 unemployed—for the most part women. Criminal activity is as follows: minor disorderly conduct due to drunkenness and petty thefts. We have no meetings, picketing or other political actions."

The road from the check point at Mirnyy leads past a pantheon. Fifty- four rocket specialists who perished during accidents are buried here in a small square at the entrance into the city, where an Eternal Flame burns.

A Cosmos rocket exploded at the test site on 26 July 1973. Six fellows perished and another three died of their wounds after several days. On 18 March 1980 a Soyuz

booster tumbled from the launch pad. According to the recollections of witnesses, there was no explosion. But the people burned like torches in the fuel which poured out. The details about these catastrophes are being kept secret to this very day. In any case, the military categorically suppressed our interest in the catastrophes, declaring that all the documents concerning them have been destroyed.

At seven in the morning the residents of Mirnyy run after a special train, which here is called a diesel, and which branches out to the sites. And they return to the city by nine in the evening in the same diesel. But those who have jobs close to Mirnyy get to their destinations by bicycle. The transportation is obviously irregular and even funny. The garrison commander wanted to forbid it, but common sense prevailed: how will an officer ride if he has no other wheels?

During the daytime Mirnyy becomes a city of women and children. There are very few old people here. On the other hand the local maternity home is not empty; every year 100 babies are born here. At Mirnyy there are 13 kindergartens and the students are taught in three shifts. The city authorities began to build a fifth school, but funds sufficed only for a "box."

According to Lieutenant General Zhuravlev, test site chief, the principal problem at Mirnyy is a lack of money.

"There is funding only for the payment of monetary allowances to military personnel, and that with a lag up to two weeks," says the lieutenant general, who is 53 years old. "There are virtually no funds for the remaining test site needs. We owe about nine billion rubles for electric power and other services. A total of 255 families of officers have no quarters, another 1172 families need an improvement in living conditions and we have not built quarters for two years now."

The imprint of abject poverty of the soldiers can be seen everywhere in Mirnyy. Up to 70% of the officers and ensigns have established their own kitchen gardens. Potatoes are planted even in the area near the general hospital where the president of Russia spent the night and where higher army officials stay. It is true we were not there when the colonels and the scientists with the degrees explained that they grow potatoes not as a pastime, but in order to feed their families.

At the teaching center, which prepares specialists for the rocket forces of Russia, the trainees eat gruel three times a day.

"I can no longer remember when there was fresh meat," says the cook, private Starinskiy. "I prepare barley or oats gruel with filler, an omelet made from powdered eggs and soup from canned milk. We have not tasted fresh cabbage this year."

The furniture in the barracks is old and the sports training equipment and exercise bars are made from some cast-off pipes and square plates. And the floors are rubbed with a lusterless mastic which they make themselves from remnants of cakes of soap.

At the Lesnaya Polyana sanitorium, where small children with bronchial and pulmonary diseases are treated, there has long been a need for replacing the worn-out sanitary equipment and the plastic floors in the classrooms have deteriorated, exposing dusty concrete. At the "Zvezda" sports complex frail gymnasts train in a hall where the cold is the same as in the street. They showed us the best kindergarten in the city. But here also the crumbling walls, due to the nonavailability of money for repairs, are draped with amusing curtains.

At Mirnyy only the name is civilian. In actuality it is a military city. Here there is nothing which can be privatized—even the apartment in which you live. The prices in all the stores are identical—they are set by the army exchange. The only observable aspect of a market economy is solitary kiosks with chewing gum, Snickers and other imported goods. Merchants from abroad, even from nearby countries, are not admitted to Mirnyy. And our Russian merchants are given a time of two days for conducting their business. Accordingly, Mirnyy offers no hospitality to serious entrepreneurs. Especially after what happened at the military bakery.

In former times, in addition to bread for the soldiers, various kinds of long loaves, rolls and buns were baked here from high-quality flour for the civilian population. But beginning this year the command, apparently concerned about the economy, excluded this higher-quality flour from the military ration. Its deliveries to the plant were suspended and the line for long loaves stopped.

"However, entrepreneurs were found who proposed to me that long loaves be baked for the city from their high-quality flour," says Major Molodtsov, who heads the bread plant. "The deal was advantageous and I agreed. But then there was a sudden inspection by the Leningrad Military District. And for this initiative with the long loaves I was reprimanded for incomplete adherence to military regulations."

Now the entire population of Mirnyy, including small children, eats only soldier's bread.

While returning to the city in the evening after a rocket launch from the Lesnoye site we ran into a so-called "operation," as they call the movement of military equipment here under the cover of darkness. An armored transport vehicle blocked our path, freeing the way for a column of powerful tractors with seven pairs of enormous wheels, each of which carried a massive steel column on its "back." These were the highly touted SS-25 rocket complexes.

"The power of Russia is growing fast, like our poplars," joked one of the officers.

But for some reason or another I did not want to smile at the appearance of man's creations capable of annihilating everything living on the planet.

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